385

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MIRROR IMAGE STIMULATION AND BEHAVIOURAL DEVELOPMENT IN STUMPTAIL MACAQUES.

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CONTENTS

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ABSTRACT

Mirror image stimulation (MIS) is reported to elicit persistent social responses in monkeys, in contrast to most humans and great apes, who exhibit self-recognition. The abnormal features of a mirror image as a social stimulus have generally been ignored in monkey reports, whereas research with other animals has identified some important differences between MIS and other stimuli.

Differential agitation during separations in peer-reared and mirror-reared infant stumptail monkeys suggests that even the limited opportunity for physical contact with a reflection renders it a sub-optimal attachment-eliciting stimulus. Mirror-rearing appeared to only slightly diminish responsiveness to pictures of conspecifics, compared to peer-rearing. Animals reared with no form of social stimulation exhibited less responsiveness to pictorial stimuli, and engaged in more abnormal and self-directed behaviours than mirror- or peer-reared animals, indicating that a mirror can at least partly compensate for the absence of a true social companion during rearing. The extent of abnormal behaviours in alone-reared stumptail monkeys appears to be considerably less than that reported in rhesus monkeys.

The mirror was reacted to as a social partner by mirror-reared animals, and correlations between behaviours, and between measures of a single behaviour, were similar in mirror- and peer-reared groups. However, a live cagemate received 50% more social behaviour than did a reflection, with play behaviours producing group differences in rate, duration, bout length, and variability. MIS or a peer behind Perspex reduced separation agitation in pair-reared but not group-reared infants.

In comparison to a peer behind Perspex, MIS received positive responses in mirror-reared and pair-reared animals, whereas group-reared animals reacted more ambivalently to the abnormal animal represented in the mirror.

Those mirror-reared animals who received additional experience of a peer behind Perspex during rearing reduced responding to the mirror, whereas responsiveness in mirror-only-reared animals persisted. Peer-only-reared animals were also highly responsive to MIS, possibly due to novelty. Alone-reared subjects, when tested in a familiar setting, were the most responsive of all the subjects to MIS.

None of the subjects exhibited self-recognition, even although some had approximately 3,500 hours of experience of a triple mirror image effect, and an additional six months group mirror experience.

Some results were obtained with small numbers of subjects, so caution is required in interpretation.

CHAPTER ONE. INTRODUCTION: BEHAVIOURAL RESPONSES TO MIRROR IMAGE STIMULATION

1.1 Mirror Image Stimulation

Experimental ethology and comparative psychology are both characterized by their common method of employing artificial stimuli to elicit behavioural reactions from subjects. In the study of social behaviour, stimuli of varying approximation to a natural stimulus are presented with the aim of identifying perceptual mechanisms involved in given responses (e.g. feeding responses in herring gull chicks, Tinbergen, 1953; aggressive displays in Siamese fighting fish, Figler, 1972). In addition, stimulus features can be controlled over long periods of time, to permit assessment of the developmental consequences of exposure to specified rearing conditions. Examples of the latter research strategy would include studies which examine the behavioural consequences of imprinting experiences in birds (reviewed in Bateson, 1971), and studies which evaluate social development in infant non-human primates reared in environments in which the amount and quality of external stimulation has been controlled (see e.g. Harlow and Mears, 1979; Sackett and Ruppenthal, 1973; Chapter 2). These research techniques are primarily geared toward questions about proximal causes and ontogeny of behaviour, which complement evolutionary and functional considerations.

The principal stimulus employed throughout the present study is mirror image stimulation (MIS), which comprises 'situations in which an animal is confronted with its reflected image' (Gallup, 1968 p. 782). While MIS has often been tested with regard to its immediate effects on behaviour (Gallup, 1968), until now it has never been used as a long-term social stimulus with mammals. The present study examines both

immediate and long-term reactions to MIS using an Old World monkey, namely the stumptail macaque (Macaca arctoides) as a subject species. As will be seen later, the reactions of macaques to MIS have never been thoroughly investigated.

In discussing the social stimulus properties of MIS, Gallup (1968) notes that MIS (a) presents an image of identical age-sex class and species as the observing animal; (b) constitutes a conspecific which behaves abnormally in that it only replicates the observer's actions, never initiating or terminating interaction; and (c) depicts a conspecific which may frequently appear and disappear suddenly, depending on the size of the mirror. These points should be borne in mind when evaluating reports of mirror image reactions. Gallup also points out that such features, in addition to the absence of normal cues from other sensory modalities, imparts a certain degree of novelty to a situation of mirror image confrontation. Of course this premise holds providing that the observing organism is experienced with normal conspecifics, which is probably the case in most studies reporting the responses of animals to MIS. One feature of the present study is that some animals are reared exclusively with a mirror as a social companion, and their behaviours compared with those of animals reared with a true social partner.

MIS has featured in an impressive range of behavioural studies, with subjects ranging from cockroaches to humans. The following review represents the first comprehensive compilation of this information, although Gallup, (e.g., 1975, 1979, 1980) has thoroughly reviewed the research on self-recognition, and has briefly summarized some work in other areas. Firstly, the uses of MIS in human research are described, emphasizing the importance attached to the emergence of self-recognition and the functioning of the self-concept. The research on self-

recognition in great apes is then considered. This is followed by a review of MIS research on other animals, with the aim of contrasting the methodological precision of some of these studies with the work which has been done on monkeys. Finally, the existing literature on mirror image responses in monkeys is reviewed in detail, progressing toward the rationale for the present study.

1.2 Self-recognition in Humans

The most significant aspect of MIS from the point of view of human behaviour is that a mirror promotes visual self-inspection (Gallup, 1971). Humans commonly employ mirrors to check on, and sometimes to re-arrange their own appearance. Implicit in the use of mirrors for such purposes is the capacity for self-recognition, i.e., the reflected image is correctly interpreted as a representation of one-self, rather than another person. Self-recognition itself is based upon an internal representation of the self, which is referred to as 'self-knowledge' or 'self-awareness' (e.g. Gallup, 1975; Lewis and Brooks-Gunn, 1979).

Study of the ontogeny of self-recognition in humans is germane to the wider issue of the development of a self-concept. Gallup (1968, 1979), and Lewis and Brooks-Gunn (1979) describe some early reports of the reactions of human infants to mirrors, which suggested that self-recognition was not detectable before the age of 10 months. More recent studies have improved the methodology of research in the area, and results indicate that it is not until well after 10 months of age that self-recognition can be unambiguously demonstrated. The best known study is that of Amsterdam (1972), who recorded mirror image reactions of infants ranging in age from 3 to 24 months of age. The strictest criteria for self-recognition were: (1) pointing to self or saying own name in response to the mother pointing to the reflection and saying

'See' or 'Who's that'; (2) touching a spot of rouge which the mother had previously applied to the infant's nose, or otherwise using the mirror to examine the mark. No infants below 17 months of age satisfied these criteria for self-recognition. Over 60% of infants between 21 and 24 months of age exhibited self-recognition. Between the ages of 6 and 14 months, the majority of infants displayed 'sociable' behaviour toward the reflection, for example smiling, touching the image playfully, and vocalizing. This is of interest in view of the findings that most animals appear to persist in directing social responses toward the image even after prolonged exposure to MIS (Gallup, 1968, 1975; see following sections).

Schulman and Kaplowitz (1977) also reported social overtones in the mirror image reactions of human infants aged 7 to 17 months, while most infants over 19 months responded appropriately to marks on their faces. The thorough studies of Lewis and Brooks-Gunn (1979) showed that mark-directed responses were absent in 9-12-month old subjects, were present in one quarter of 15-18-month old infants, and were exhibited by three quarters of the subjects aged 21-24 months, which agrees well with other research, although they found that sociable responses continued when self-recognition was also evident.

In evaluating human self-recognition studies, Gallup (1979) has pointed out that in the critical tests, a mark is usually made on the infant's nose. By being in the infant's direct field of vision, a marked nose is capable of attracting attention even without the aid of a mirror, and this could facilitate correct interpretation of the mirror image. Bertenthal and Fischer (1978) mentioned that only 3 out of 13 self-recognizing infants also touched the spot of rouge in the absence of the mirror, but Gallup's criticism seems valid, and future studies are advised to mark the infants on the brow, as has been done in nonhuman primate studies.

In general, however, the above studies agree that use of one's

mirror image to investigate marks on one's face does not usually appear before 1.5 years of age. There are two rather anomalous studies. One of them involved marking the subjects by sticking red tape onto a cheek (Dickie and Strader, 1974). In addition to the possibility of tactile cues in this situation (Gallup, 1979), visual cues might also be present, since young infants might have a direct view of their flabby cheeks. Furthermore, the oldest group of infants in this study averaged 18 months of age, so it is not surprising that little evidence of self-recognition was obtained. It seems possible that Dickie and Strader were unaware of Amsterdam's (1972) study, since they did not cite it.

The second problematic study is that by Bertenthal and Fischer (1978), who conceptualized self-recognition as progressing through an orderly sequence of stages, akin to the stages of object permanence postulated by Piaget. The reader is referred to Gallup (1979) for several criticisms of this paper.

A recent methodological development in the study of self-recognition in infants has been the utilization of videotape playback instead of MIS (see e.g., Amsterdam and Greenberg, 1977; Lewis and Brooks-Gunn, 1979). Video techniques allow more systematic control of variables such as colour, imitation by the image, and eye-to-eye contact (Papousek and Papousek, 1974), although the latter variable could also be controlled by an appropriate arrangement of mirrors. These studies have typically used infants below the age at which mirror-mediated self-recognition is clearly evident, but they have reported that 'self-conscious' behaviours may appear shortly after 10 months of age. Lewis and Brooks-Gunn (1979) reported differential amounts of play and imitation in infants viewing contingent and noncontingent tapes of self, and noncontingent tapes of another infant, which suggests that

infants as young as 15 months of age can clearly recognize videotape representations of self. Certainly this work suggests that other criteria for self-recognition may produce different pictures with regard to the age at which self-recognition is first evidenced. No-one has used video techniques to assess self-recognition processes in nonhuman primates.

One cause for concern in studies of early mirror image reactions in humans is related to the behavioural categories employed. Although self-recognition might not be clearly present until 18 months of age or later, some investigators (e.g., Amsterdam, 1972; Schulman and Kaplowitz, 1977) have intimated that the onset of self-recognition may occur earlier, on the basis of behaviours such as 'self-admiration' and 'coyness'. While implying the presence of self-awareness, such descriptions would seem to pose difficulties with regard to definition and reliability. Similarly, 'social' responses of infants toward their reflections remain to be validated. One major problem is that none of the above studies compared the behaviours of an infant in the presence of a mirror with those shown in the presence of another infant. When this is done, differences are found. Without referring to any animal or human studies on MIS reactions save an early report by Dixon (1957), Field (1979) compared responses of 3-month old infants to MIS and to a peer. Field obtained behavioural differences, i.e., preference for the mirror, but more smiling, cooing, reaching and squirming in the presence of the real infant; and physiological differences, namely heart rate decreases during MIS sessions, and increases in peer sessions. Of course Field's data need not suggest that 3-month old infants can self-recognize, but they indicate that very young infants are sensitive to differences between MIS and a live peer. It would be interesting to repeat Field's study using older infants, when 'sociable' responses

toward the mirror are reported to predominate. There is no work comparing psychophysiological responses to MIS and to real social stimuli in animals.

One question which the research on self-recognition does not obviously answer is the extent to which self-recognition depends on previous experience with one's reflection. With most infants age and mirror exposure will be positively correlated. Although mainly anecdotal, some lines of evidence suggest that older individuals do require some experience with their reflection before self-recognition becomes automatic. Gallup (1977) cites von Senden's (1960) case of a man whose sight was surgically restored after being blind from an early age. This person initially misinterpreted his reflection as being another person, but came to learn that it was himself in the mirror. Victor, 'The Wild Boy of Aveyron' when first confronted with a mirror searched behind it (as do monkeys, see below). He also initially reached for the reflection of a piece of food offered to him, before using the image to guide his reaching behind to take the real object (Bonnaterre, 1800, cited in Lane, 1976). Finally, initial mirror image reactions in inexperienced 'primitive' people also suggest the necessity of mirror image experience for self-recognition. Carpenter (1975) describes how men of the Biami, from Papua New Guinea, were startled on being shown their reflections. They stood staring at the image, but came to groom themselves in front of the mirror after a few days. As will be seen later, the length of MIS experience has also been an important factor in studies of self-recognition in nonhuman primates.

MIS and video techniques have been used to assess the capacity for self-recognition in clinical settings. Some of this work predated the systematic study of self-recognition. Sayons and Brown (1953) developed a reflecting surface in which subjects could control the

amount of image distortion. The apparatus was developed for use in studies of 'self-percept'. Subsequently, Traub and Orbach (1964) proposed the 'adjustable body-distorting mirror' as a method for the study of disturbances in body image. Some difficulties were encountered in validating the instrument with normal subjects (Orbach et al., 1966), but psychotic patients were reported to accept an unusually wide range of distorted reflections as being accurate. Gallup (1968) and Lewis and Brooks-Gunn (1979) describe some early accounts of unusual mirror-related behaviours in psychotic individuals. More recently, two studies have investigated self-recognition in profoundly mentally retarded (PMR) adolescents and adults, using marking procedures (Harris, 1977; Pechacek et al., 1973). Even after elaborate pre-test mirror confrontations, PMR individuals failed to use ther reflections to investigate marks made on their faces. Such results suggest that PMR individuals might possess an impoverished self-awareness, but it is conceivable that factors related to compliance and motivation influence the outcome of these types of investigation.

In contrast to PMR individuals, Down's syndrome children are capable of self-recognition, although it appears later in this population than in normal children (Mans et al., 1978; but see Brooks-Gunn, 1977, cited in Gallup, 1979). Using a video technique, Hill and Tomlin (1981) recently reported the presence of self-recognition in most of their Down's syndrome sample. In contrast, children diagnosed as 'multi-handicapped' were less responsive to their images than were the Down's syndrome group, and less than half of the multihandicapped children showed evidence of self-recognition. Using two television monitors, Neuman and Hill (1978) found that autistic children preferred to look at current televised images of themselves than at previously recorded images. These children, all over 5 years old, also responded positively

in the mark tests which were conducted. It has not yet been determined whether autistic children exhibit a lag in the onset of self-recognition, as has been found with Down's syndrome infants.

In summary, as well as contributing to the increasing sophistication of research on self-recognition and intellectual functioning, clinical studies of the type reviewed above have provided new perspectives from which to view certain psychopathological disorders. They also highlight the desirability of paying close attention to comparison stimuli in studies which use MIS, and of considering problems of motivation. These are issues relevant to the MIS work with animals, as will be seen later.

1.3 Consequences of Mirror-induced Self-awareness

Mirrors have long been incorporated into rituals and myths, such as the belief that the breaking of a mirror will be followed by bad fortune, and the old Jewish custom of covering mirrors following a bereavement, so that any signs of joy would be hidden (Wagner, 1895). Such phenomena are tied into a mirror's ability to remind us of ourselves, i.e., of enhancing self-awareness. A recent line of research in social psychology has focused on the self-awareness inducing effect of MIS, and the ways in which such self-awareness can influence behaviour. Duval and Wicklund (1972; Wicklund, 1975) theorized that attention could be directed either toward the environment, or toward the self, the latter condition producing a state of 'objective self-awareness' (OSA). Various situations have been employed to create self-awareness in the laboratory, including MIS. That a mirror can focus attention on the self has been demonstrated in studies which, for example, obtained more self-referents from subjects who completed a sentence completion task in front of a mirror than from subjects in a mirror-absent condition (Carver and Scheier, 1978). This effect

was not obtained with vampires (Carver and Scheier, 1979). The theory of objective self-awareness postulates that the state of OSA evokes a process of self-evaluation, in which the self-aware person compares his behaviour on a currently salient dimension with an 'ideal' standard, such as a socially acceptable attitude. Self-evaluation usually leads to self-criticism, because of the discrepancy perceived between the ideal standard and actual behaviour. The discrepancy is unpleasant, so the person acts to reduce it.

The literature which has stemmed from this self-awareness theory is too large to be reviewed here, but in the way of example, MIS-induced self-awareness has been found to increase consistency between expressed attitudes and later behaviour, for example with regard to pornographic material (Gibbons, 1978); and to decrease cheating on a task when performance is believed to be due to chance, but to increase cheating when performance is believed to depend on ability (Vallacher and Solodky, 1979). Recently the theory of self-consciousness has been reshaped by Buss (1980), who, along with Duval and Wicklund (1972) denies self-consciousness to non-humans. Buss acknowledges that self-awareness need not result in self-criticism, but may also simply enhance subjective experiences. Thus subjects made self-aware by a mirror are less susceptible to suggestions about the effects of a placebo substance, and react more intensely if deliberately angered (experiments reported in Buss, 1980). These effects are thought to occur because self-aware individuals are more cognizant of their affective states, which translates into behaviour. A final, recent example of this research is a study in which people who were fearful of snakes were requested to approach and handle a snake. Subjects tested in the presence of a mirror achieved lower approach and contact scores than did subjects in a no-mirror condition (Scheier et al., 1981).

Only one study appears to have investigated whether mirror-induced self-awareness affects behaviour in children. Beaman et al. (1979) investigated transgression (stealing candies) in children ranging from 1 to 13 years or over. Children who took candies from a bowl in front of a large mirror were less likely to take more candies than instructed than children who were not confronted with MIS, but a significant effect was evident only in children older than 9 years. In discussing this age difference, Beaman et al. acknowledged the difficulty in distinguishing whether the children were deliberately transgressing or simply 'failing to regulate' (P. 1845). However, this research suggests that while infants may recognize themselves in a mirror at around 2 years of age, they might not be susceptible to effects of mirror-induced self-awareness seen in older children and adults. This issue will be returned to in the Discussion (Chapter 9), but it may also be kept in mind when considering the literature on self-recognition in great apes, which is reviewed below.

1.4 Self-recognition in Great Apes

Empirical research in the area of self-awareness has recently been extended to include investigations of nonhuman primates (Gallup, 1975, 1977a, 1980). Desmond (1979), however, attributes demonstration of self-recognition in an ape to the Hayes (1952), whose home-reared chimpanzee Viki used mirrors when playing at dressing up and when washing her face. In fact the first, albeit unwitting documentation of self-recognition in a great ape may go back even further, to Furness (1916), who attempted to train an orangutan to speak by moulding the desired shape of the ape's mouth as they both sat in front of a mirror. Presumably Furness was working under the premise that the orangutan was aware that the reflection was itself, and could use it to monitor its

performance. However, self-recognition was not emphasized by either Furness or the Hayes, and this aspect of the reports has generally been ignored. Usually, early reports of responses of great apes to MIS (and some recent ones, e.g., van Lawick-Goodall, 1971) describe varying degrees of curiosity, aggressiveness, playfulness, reaching behind the mirror, and learning to use the mirror to look obliquely at the environment (Köhler, 1924; Yerkes and Yerkes, 1929). Yerkes also intimated that socially deprived apes appeared particularly responsive to MIS, and Köhler mentioned that his chimpanzees showed interest in their reflections in water.

With Gallup's (1970) demonstration of self-recognition in chimpanzees, the notion of self-awareness in non-human primates took on greater significance. There are probably two main reasons for the strong impact of Gallup's work. Firstly, the 'dye test' introduced by Gallup constituted an objective method of assessing the presence of self-recognition. Secondly, confirmation of self-recognition in chimpanzees was particularly interesting set in a framework of other contemporary research developments in primatology. These two points are elaborated upon below.

As mentioned above, the home-reared chimpanzee Viki watched herself in mirrors while playing and washing. Other home-reared chimpanzees do likewise, and those trained in American Sign Language are reported to sign their names ('Washoe', 'Lucy', 'Nim') or 'me' upon seeing themselves in a mirror (Gardner and Gardner, 1978; Temerlin, 1975; Terrace, 1979). Chimpanzees and orangutans also show a range of other types of mirror-related behaviours which are suggestive of self-recognition, for example chewing food in unusual ways while watching it in a mirror, and inspecting otherwise visually inaccessible parts of the body (e.g., Gallup, 1975; Lethmate and Dücker, 1973; M.Temerlin,

1975; J. Temerlin, 1980). However, such information is difficult to quantify and define clearly. Gallup (1979) has also urged caution with regard to readily accepting linguistic self-reference in MIS situations as indicating self-recognition. Rather, such responses might be simple conditioned responses maintained by a history of positive reinforcement.

The results of Gallup's dye test objectively demonstrated self-recognition in champanzees. The procedure was as follows: four chimpanzees were housed individually and each presented with a mirror 3.5 metres away, for 8 hours on two consecutive days. This was followed by a further 8 days exposure at 0.5 metres. Self-directed behaviours suggestive of self-recognition were apparent by the third day, but the dye test was not conducted until after ten days. The mirror was removed and the animals were given a general anesthetic. While unconscious, each chimpanzee was marked on the brow and on an ear with an odourless, nonirritant red dye. After the chimpanzee had fully regained consciousness, it was observed to ascertain whether it would manipulate the marks during a 30-minute period. Without the mirror, the chimpanzees virtually never touched the marks. In contrast, during a 30-minute test following reinstatement of the mirror, there was a 25-fold increase in mark-directed responses, the chimpanzees using the reflection to guide their fingers to the marks. This was followed by visual, and in one case olfactory, inspection of the fingers. Overall viewing time, which had declined over the ten days, also recovered during the dye test. Two additional chimpanzees were tested, but without the initial days of MIS. They did not respond to the marks when shown their reflections, indicating that the original chimpanzees had learned appropriate use of the mirrors during the previous ten days exposure.

Self-recognition in chimpanzees was confirmed by Lethmate and Dücker (1973), who also obtained it in orangutans. More in line with studies of human infants, the marks in this latter study were applied while the subjects were conscious and being distracted, during grooming by their keepers. An advantage over the human studies was that the marks were confined to the animals' heads. Some of Lethmate and Dückers' chimpanzees exhibited behaviours suggestive of self-recognition as early as the first day of MIS. The two orangutans tested also appeared to self-recognize after a few days of mirror exposure. All of these pongids responded positively on the mark test, conducted 2 weeks after the introduction of the mirror. Suarez and Gallup (1981) recently obtained positive dye test performance in chimpanzees with only 4 days of mirror experience, and in an orangutan tested for the first time after 8 days.

The second likely reason for the interest surrounding the finding of self-recognition in apes is that the phenomenon was publicized at a time when findings in other areas were leading to re-evaluations of psychobiological relationships among primates. Studies of natural history (e.g., van Lawick-Goodall, 1968), language acquisition (Gardner and Gardner, 1969), cross-modal perception (Davenport and Rogers, 1970), neuroanatomy (Shantha and Manocha, 1969), and biochemistry (Wilson and Sarich, 1969) were all pointing toward a greater evolutionary relationship between man and the great apes, especially chimpanzees, than was previously generally acknowledged. The demonstration of self-recognition in chimpanzees constituted additional evidence of a psychological continuity between chimpanzees and humans (Desmond, 1979; Gallup et al., 1977; Meddin, 1979). Gallup described his 1970 study as 'the first experimental demonstration of a self-concept in a subhuman form' (p. 87).

Both Gallup (1970) and Lethmate and Dücker (1973) tested other primate species to obtain some idea of the range of species capable of self-recognition. Gallup tested representatives of three macaque species, while Lethmate and Dücker exposed another ape, the gibbon, as well as capuchins, spider monkeys, macaques, and baboons to MIS. The responses of these primates to mirrors are considered in detail in Section 1.9. It is sufficient to note here that these animals have not been observed to exhibit any behaviours indicative of self-recognition.

Evidence reviewed so far indicates that among the primates, two species, namely the chimpanzee and the orangutan, are capable of self-recognition, while no positive evidence exists for monkeys or lesser apes. Information on the question of self-recognition in the remaining great ape, namely the gorilla, is still scarce. The evidence which is available is puzzling. Lethmate (1974) briefly reported that unlike chimpanzees and orangutans, gorillas showed little interest in their mirror images, especially with extended exposure. Two out of six gorillas used the mirror while picking at their teeth or manipulating some other body part. During a dye test, only two out of four subjects clearly exhibited self-recognition. A home-reared gorilla, Koko, uses mirrors to check her appearance in several contexts (Patterson, 1978), and would certainly seem to self-recognize. Hoyt (1941) reported that the home-reared gorilla Toto used to stand in front of a mirror and examine loose teeth or preen herself. However, she also unpredictably attacked the reflection. Benchley (1944) described how a mature zoo-living gorilla would display while observing his reflection in a pool of water, and splash the water. In a formal self-recognition study, Suarez and Gallup (1981) failed to observe any behaviours suggestive of self-recognition in four lowland gorillas tested in a paradigm

which they also successfully used with chimpanzees and an orangutan. Mirror viewing time decreased in the gorillas over 8 days. Strangely, it partially recovered over the next 8 days, but the authors do not comment on this. A particularly surprising aspect of the results was that viewing time did not increase at all in the gorillas when their heads and wrists were marked. In contrast, mirror viewing generally rises even in non-self-recognizing monkeys during a dye test, which suggests that the gorillas were uninterested in the image. Suarez and Gallup cite a personal communication which also reports the absence of self-recognition in gorillas. Since the gorilla shares many psychobiological characteristics with the other hominoids (e.g., Dixson, 1981), further research is necessary to identify conditions under which gorillas do or do not appear capable of self-recognition.

In addition to demonstrating the presence of self-recognition in mirror-experienced chimpanzees, Gallup and his colleagues (1971) discovered that isolation-reared chimpanzees did not appear to self-recognize, either during ten days of MIS, or in a subsequent dye test. One month of remedial physical contact with a conspecific was followed by the appearance of self-recognition in a mirror, while visual contact without physical access was not followed by self-recognition (Hill et al., 1970). These findings were taken as support for the hypothesis of Cooley (1912, cited in Gallup et al., 1971), that social interaction is a requisite for the emergence of a sense of self.

In concluding this review of research on self-recognition in great apes, it is worth noting that there are no longitudinal or cross-sectional studies on the development of self-recognition in apes. From the study by Hill et al. (1970), it can be said that self-recognition is demonstrable in chimpanzees at 20 months of age, but the course of events preceding this stage of development is unknown, in some contrast to the picture for human infants.

What of nonhuman primates other than great apes? The evidence suggests that they do not exhibit self-recognition, but appear to respond to the reflected image as though it were a conspecific. Further research on the question of whether monkeys could self-recognize seemed warranted. Furthermore, it seemed possible that a detailed analysis of how monkeys respond to MIS, with its peculiarities, comparing it with other types of social stimuli, could contribute some information about cognitive and perceptual mechanisms involved in social behaviour in monkeys. A thorough survey of the literature for accounts of the responses of animals to mirrors revealed that the best social behaviour analyses using MIS has been done on fishes. The most relevant material is presented below. This is followed by discussions of MIS reactions in birds, reptiles, and nonprimate mammals, then finally by a review of the monkey literature.

1.5 Mirror Image Stimulation in Fish

Reports concerning responses of fishes to MIS are too numerous to be exhaustively catalogued here. Therefore the following review is selective. Some relevant background material is presented, with most attention being paid to studies which are of particular relevance to the issue of MIS as a technique for analyzing social behaviour. Gallup (1968) has cursorily described some reports dating before 1968.

Most of the current research in this area stems from Thompson (1963). He found that in decreasing order, MIS, a moving model of a conspecific in aggressive display, and a stationary model were able to increase an operant response (swimming through a ring) over baseline levels in adult male Siamese fighting fish (Betta splendens). Earlier observations had suggested the same order of the stimuli in their ability to elicit aggression in bettas, which suggested that

this attribute of the stimuli might be determining their respective strengths as reinforcers. Two subsequent studies (Goldstein, 1967; Hogan, 1967), using yoked controls, confirmed MIS-reinforced ring swimming, and also its extinction when MIS was withdrawn. These two studies also showed that increased general activity following MIS was not a major factor underlying the increases in responding.

To test whether extinction decrements in the MIS paradigm could be due to habituation of the aggressive display, Baenninger (1966) measured the tendency of male bettas to approach three areas of a tank. At one end of the tank the subject could see its own mirror image, while at the other end it could see a live conspecific in an adjacent tank. In the centre area of the tank it could see neither of the stimuli. With increasing time, fish spent more time in the central portion of the tank, after an initial preference for the mirror. A later study (Baenninger et al., 1969) used an un-habituated conspecific instead of a habituated one as in the 1966 experiment. A preference for MIS was again obtained, and MIS also elicited greater frequencies of the single component of the aggressive display that was quantified, namely gill cover extension.

A more detailed investigation of habituation of displays toward MIS monitored several distinct components of the aggressive display (Clayton and Hinde, 1968). The display in general waned over the 10-day exposure period, but different components exhibited rather different habituation curves. For example while frequency of gill cover erection dropped sharply on the second day and gradually thereafter, biting increased in frequency toward the end of the ten days, although this response was always quite rare. The total duration of gill cover erection, however, increased over the first three days, and remained fairly stable thereafter. Although Clayton

and Hinde did not compare MIS with live stimuli in the experiment, they suggested that the observed pattern of waning of aggression to MIS might be related to the absence of certain features of a 'normal' aggressive encounter.

MIS now features in a large number of studies of aggression in Betta splendens, and in the paradise fish, Macropodus opercularis (e.g., Melvin and Anson, 1970). In addition to studies of the reinforcement value of aggressive display and its habituation, MIS has been used in investigations of the effects of punishing aggression (e.g., Adler and Hogan, 1963); effects of alcohol (Raynes et al., 1968), exogenous catecholamines (Baenninger, 1968), social isolation (e.g. Davis et al., 1974), 'priming' (Hogan and Bols, 1980), cross-fostering (Kassel and Davis, 1975), and chemical composition of water on aggression (Dore et al., 1978; Ingersoll et al., 1976).

A persistent problem in several of the above studies, particularly those examining reinforcement and habituation, is that it is not easy to determine what aspects of the total stimulus situation are maintaining responding in the fish (see Taylor, 1979). At least four, non-mutually exclusive interpretations may apply to findings regarding MIS responses in fish. Firstly the performance of an aggressive response itself might be a rewarding event for the animal (positive reinforcement). Secondly, the normal consequences of the aggressive display, such as the removal of an opponent, might be an important consideration (negative reinforcement). Thirdly, the mere sight of a conspecific could be rewarding (sensory reinforcement). Fourthly, peculiarities of MIS relative to other situations could maintain responding, perhaps even resulting in eventual avoidance (e.g., a novelty interpretation). The problem of distinguishing among these various factors should be borne in mind when considering the behaviour of other animals confronted with MIS. Some more

illustrative examples are presented below, followed by descriptions of some studies which seem to have taken a more analytic approach.

Baenninger (1970) found that male bettas that were dominant in prior encounters with live opponents performed ring swimming responses for MIS at higher rates than did subordinates. More interestingly in the present context, however, he also demonstrated that in the continuous presence of MIS fish learned to respond to extinguish the mirror for 25 seconds. There are various possible interpretations of this. Perhaps the habituation of the aggressive display proved aversive, and the fish learned to check habituation by reducing exposure to MIS. Another possibility is that MIS developed aversive qualities by virtue of its failure to produce normal response sequences (see also Rhoad et al., 1975). Later Baenninger and Mattleman (1973) demonstrated that despite the continuous presence of a mirror to which fish had habituated, the subjects performed operants to produce an additional mirror, to which they exhibited some displays. Two possible explanations were that habituation of the aggressive display was narrowly target-specific, and that changing visual stimulation might have been the primary factor supporting operant performance. It is still not clear, of course, whether reinforcement would reside in the mere sight of a conspecific, the peculiar behaviour of the mirror image, or whether a less specific change in visual stimulation would have produced similar results.

The extent to which MIS is perceptually comparable to a live conspecific in fish has also been neglected in studies comparing operant performance for display reinforcement with that for food reinforcement. Hogan (1967) obtained a markedly lower asymptotic performance for MIS than for food in bettas; extinction was also more rapid with MIS. These results suggested that the reinforcing effects of the two types

of stimuli involved different physiological systems. This conclusion was further supported by the finding of appropriate adjustments to changes in fixed-ratio schedules for food reinforcement, but not for MIS, meaning that in the latter condition some rewards were lost (Hogan et al., 1970; Hogan and Roper, 1978). However, it is not clear whether such differences truly reflect differences between food and aggression reward systems, or whether the weaker performance obtained with MIS is partly due to this stimulus, rather than a live conspecific being used.

Several lines of evidence indicate that MIS possesses reinforcing properties outwith its display-eliciting effect. Baenninger and Mattleman (1973) observed over twice as many ring swimming responses for MIS than ensuing displays to the reflection. Using non-aggressive goldfish, (Carassius auratus), Gallup and Hess (1971) found a threefold preference for MIS over a live conspecific, indicating that aggressive motivation is not a necessary component of attraction to MIS. Clearly, such phenomena emphasized the desirability of paying close attention to the behaviours exhibited in various conditions, as in the early studies by Clayton and Hinde (1968) and Simpson (1968). Bols and Hogan (1979) collected frequency and duration measures of both attraction and aversion to stimuli. Percentage of choice, runway speed, and latency to leave the startbox all favoured food over MIS, which was preferred to an empty goalbox. Avoidance responses (air gulping and turning away) were more frequent with MIS than with food. These results could suggest that aggressive situations have aversive qualities, but once more the use of MIS as the aggression-eliciting stimulus introduces as yet unevaluated contamination into the procedure.

Critical to the issue of whether MIS and live stimuli differ in their behavioural effects, are studies which directly compare the two stimuli. In one thorough study Figler (1972) employed four stimulus conditions, namely MIS, an unhabituated conspecific, a habituated conspecific, and a stationary 2-D cutout; and five measures of aggression: frequency and duration of gill cover erection, frequency and duration of fin erection, and frequency of air gulping. Virtually all measures produced the following decreasing order of stimuli with respect to their ability to elicit aggression: unhabituated conspecific, MIS, habituated conspecific, and cutout. Figler believed that the return of aggressive responses, combined with the unpredictability of the unhabituated conspecific accounted for this stimulus eliciting more aggression than MIS. MIS at least reciprocated the subjects' threats as long as they emitted them, which was thought to be the reason for MIS supporting more aggression than the unresponsive, habituated conspecific.

Dore et al. (1978) obtained contrasting results, namely more frequent and longer gill cover erection, and longer fin erections to MIS than to an adjacent conspecific, both of these stimuli eliciting more aggression than a full physical encounter. Dore et al. pointed out that Figler's (1972) stimulus fish was enclosed in a small tank which prevented effective avoidance responses. This might have exacerbated the amount of aggression exhibited.

Miley and Burack (1977) obtained shorter latencies to display to MIS than to a conspecific in visually habituated bettas, but higher frequencies of displays toward the live conspecific if the subjects had been isolated. Time until displays cease are also reported to be longer with MIS (Miley et al., 1980).

The final study to be described (Meliska and Meliska, 1980) compared aggression in bettas assigned to three groups: SEEMIRROR - in which the fish could see its own reflection in a one-way mirror; THRUMIRROR - in which they fish on the other side of the one-way mirror saw the SEEMIRROR fish displaying at its own image; and CLEAR - where the subject was exposed to a live conspecific on the other side of a transparent partition. Overall, the SEEMIRROR fish displayed most aggression, and the THRUMIRROR fish least. It was concluded that the identical responses of the reflection for SEEMIRROR fish interfered with normal waning processes, thus prolonging aggression. The feedback obtained by the THRUMIRROR group, in contrast, was seen as being disorganized and irrelevant in terms of the subjects' behaviours, resulting in limited responsiveness in the subjects.

From the above discussion it can be seen how MIS studies in fish have progressed from fairly elementary descriptions of MIS-related phenomena to more critical analyses of response patterns to MIS compared to other stimuli, resulting in a better understanding of perceptual and social mechanisms in the animals. MIS-based experiments using other species generally fail to replicate the degree of detail characteristic of recent research with fish. As described below, a few studies involving birds are nevertheless informative.

1.6 Mirror Image Stimulation in Birds

Anecdotal reports of the reactions of birds to MIS usually describe them as aggressive (see Gallup, 1968). In the same vein as his 1963 study with Betta splendens, Thompson (1964) showed that MIS would function as a reinforcer for fighting cocks. The two birds responded for MIS, but with schedule requirements rising from FR1 to FR75, performance for MIS was lower and more erratic than for food or

water. The birds also responded when a live conspecific replaced the mirror. No social behaviours toward the stimuli were reported. Schedule-induced aggression toward MIS has been demonstrated in the pigeon (e.g., Cohen and Looney, 1973). The aggression was described as being temporally and topographically comparable to that directed toward a stuffed or live conspecific, but no direct comparisons were made (see also Dove, 1976; Moore and Thompson, 1978). One study reported much more aggression by pigeons against a live target than against MIS (Macurik et al., 1978). The authors emphasized the moving counteraggression of the live target, and freedom from restraint of only beak-to-beak aggression as factors favouring the live bird as a target.

Both reinforcing and aggression-eliciting properties of MIS were demonstrated by Gallup et al. (1972). Three-day old chicks (Gallus gallus) attained higher runway speeds for MIS than for an empty goalbox; no other condition was included. At 7 weeks of age, chicks exhibited over 4 times the frequency of attacks to MIS than to a same-sex conspecific behind Perspex. Possible reasons for the discrepant results of Gallup et al. (1972) and Macurik et al. (1978) need not be considered here. In their own ways both studies indicate that MIS does not exactly simulate a normal social encounter in birds.

Mirrors have also been used in studies relevant to Gallup's (1968) hypothesis that social phenomena other than direct interaction should be obtainable with MIS. Tolman (1965) investigated various conditions with regard to their ability to support social facilatation of food pecking in domestic chicks. The presence of a fully accessible conspecific was associated with the most food pecks, followed in decreasing order by a conspecific near to the subject behind a transparent barrier; the same arrangement but with the stimulus bird able to move in all

areas of its chamber; a mirror; a mirror 2.5 inches further away; and an empty neighbouring compartment. However, the differences in response rate in the various conditions were not large, except between the first and the last conditions. Montevecchi and Noel (1978) found that isolation-reared chicks tested with MIS emitted frequent peep vocalizations, and pecked infrequently in the first hour of tests. In the second hour peeps declined and social facilitation of pecking took place. Social facilitation was more rapid in pair-reared chicks tested with a mirror, and intermediate in group-reared chicks. These results indicate that novelty is an important factor when evaluating the effects of social stimuli. No other forms of stimuli were tested.

Gallup et al. (1972) tested MIS for its effectiveness in reducing agitation in peer-separated chicks. The frequency of peeps emitted by the birds in the presence of a conspecific behind a transparent partition was over 3 times higher than in the MIS condition. With only an empty adjacent chamber, vocalization rate was even higher. No other behaviours were recorded. Chicks also peeped less in the presence of a mirror than with no social companion, in experiments which involved the presentation of fear-eliciting stimuli (Montevecchi et al., 1973). However, Gallup (1972) demonstrated that one fear response - tonic immobility - was prolonged in chicks by the presence of a mirror, compared to a live, unrestrained conspecific in an adjacent chamber. The latter condition shortened the response. The explanation offered was that the immobilized bird's reflection signalled continuing danger to it, thereby perpetuating the reaction.

Social stimuli are necessary for ovulation to occur in ring doves. By using MIS, Lott and Brody (1966) demonstrated that the critical visual stimuli need not be provided by a male. However, the effect of MIS was weak if it was not supplemented by conspecific auditory

stimulation, and auditory input alone did not encourage ovulation. Behaviours directed toward the experimental stimuli were not reported in any detail.

Finally, the notion that MIS and live stimuli are not perceptual equivalents is supported by the finding that finches (Passer domesticus) and parakeets (Melopsittacus undulatus) exhibited strong preferences for MIS over a conspecific in a neighbouring chamber, as measured by time spent on perches in proximity to the stimuli (Gallup and Capper, 1970). In parakeets, this preference was immediate, whereas in finches it developed after an initial preference (for 9 days) for the conspecific. It seems possible that differential familiarity of the target birds contributed to this difference, which was not explained by the authors. On the basis of findings of this type, Gallup and Capper (1970; Gallup, 1971) characterized MIS as a 'supernormal' social stimulus. A recent dissenting report, which does not refer to any previous MIS research, stated that Peking ducklings (Anas platyrhynchos) preferred a live conspecific to MIS (Shapiro, 1980). Surprisingly, the ducklings also preferred their reflections in Plexiglas to a mirror. The report is insufficiently detailed to evaluate the results properly, but the Plexiglas was bent concavely. It is conceivable that this contributed to the Plexiglas being preferred to MIS.

While all of the above accounts regarding aggression, social facilitation, fear reduction, and MIS have gone some way toward clarifying what a bird perceives when confronted with its mirror image, and how social perception may affect behaviour, there remain some disappointing lacunae. There have been very few appropriate and systematic social behaviour comparisons employing MIS and other conditions. Consequently the role of specific aspects of the various

stimuli remain vague. The little work which has been done on the responses of reptiles to MIS, described below, is similar in this respect. Consideration of one remaining bird study, by Epstein et al. (1981), is delayed until the Discussion, since it is of direct relevance to the issue of mirror image self-recognition.

1.7 Mirror Image Stimulation in Reptiles

Only three reports concerning responses of reptiles to mirrors were found during preparation of this report. Brown snakes (Storeria dekayi) were often observed in proximity to conspecifics in the wild, and would remain near a mirror when isolated in captivity (Noble and Clausen, 1936, cited in Froese,1980). Hunsaker (1962) briefly reported that Sceloporus lizards would remain close to a mirror when placed among a group of non-conspecifics. Sometimes the lizards responded aggressively to the mirror image, and sometimes they remained passive, but no data were presented. Male turtles (Terrapene c. carolina) were aggressive toward their reflections, whereas females gazed at the reflection, then turned away (Evans, 1956).

1.8 Mirror Image Stimulation in Nonprimate Mammals

MIS has occasionally been employed to elicit social behaviours in nonprimate mammals. For example Schusterman et al. (1966) elicited vocalizations and some other reactions in sea lions (Zalophus californianus) by presenting MIS, but did not distinguish clearly between MIS as a social stimulus and MIS as a simple novel object. The reaction of a bottle-nosed dolphin (Tursiops truncatus) to MIS were described as violent, after initial indifference (Dobbs, 1977). No details of the dolphin's behaviour were presented, nor control stimuli used. Gallup (1980) has recently advocated a search for self-

recognition in the large-brained cetaceans, and in elephants. The presence of the mobile trunk in elephants would make feasible straightforward mirror-plus-dye test methods, whereas with dolphins it might be necessary to employ indirect techniques, possibly utilizing videotapes.

Intense social responding to MIS was observed in newly captured yellow-bellied marmots (Marmota flaviventris, Svendsen and Armitage, 1974). Twenty-two behaviours were scored for each subject, using a one-zero technique. The study revealed wide individual differences in the nature of the responses directed toward the reflection. Some animals were primarily aggressive, some were submissive, others affiliative, with individuals showing consistency in behaviour over repeated testing. Qualitative observations also suggested that MIS responses exhibited by individual animals (e.g., avoidance) were similar to those exhibited in the wild (e.g., solitary ranging). Very few other studies have seriously addressed the question of the correlation between MIS reactions and behavioural tendencies in natural social encounters.

One of several tests conducted on dogs that had been reared with cats involved presentation of MIS (Fox, 1969). When first tested at 16 weeks, cat-reared dogs engaged in very little mirror-directed behaviour, and vocalized less in its presence, compared to dog-reared dogs. These activities increased following two weeks of social experience with conspecifics, but were still below control levels. Individual behaviours shown toward the mirror were described only informally. Fox discussed these results in terms of the cross-fostered subjects developing a disturbed species- or self-identity. Of course the latter term is open to criticism. Domestic cats also exhibit social responses toward mirrors (e.g., Guyot et al., 1980).

Only one study appears to have employed MIS to specifically investigate social facilitation in a mammal. Hamrick et al. (1971) tested the effects of three social conditions on operant performance in mice: isolation, the presence of passive conspecifics (audience), and MIS (co-action). Maze performance was best, and extinction slowest, in the MIS condition. Two points seem worth mentioning. Firstly, the audience consisted of different individual mice positioned in different parts of the apparatus, whereas the co-actor was the subject's own, uninterrupted reflection. Secondly, MIS was used as it was considered to be a 'purer' co-action stimulus than a live conspecific performing the same activity. This assumption suggests an empirical question which has not yet been investigated.

1.9 Mirror Image Stimulation in Monkeys

The preceding review of MIS-related social phenomena in fish, birds, reptiles, and nonprimate mammals, and the self-awareness literature concerning great apes and humans, provide the contexts in which the responses of monkeys to MIS will be considered. The information to be presented comes from various sources, including anecdotal reports on behaviour of home-reared or pet monkeys, formal studies in which mirrors have served as social stimuli or novel objects, and studies testing for self-recognition.

Accounts of mirror image behaviour in monkeys reared as pets are interesting in that such monkeys have often had extensive and varied access to mirrors. Such reports typically relate that the animals were interested in the mirror, that they would use the mirror to examine the environment, and that they would reach behind the mirror, presumably attempting to contact the animal depicted in the mirror (e.g., Akeley, 1928; Hughes, 1979). Tinklepaugh (1928) gave a more

formal account of some of these phenomena in a macaque. Akeley's (1928) tame vervet (Cercopithecus aethiops) sometimes slept with its face against the mirror, suggesting an affiliative relationship with the reflection. A pet long-tailed macaque (Macaca fascicularis) sometimes held its mirror behind its back, which the owner interpreted as an attempt to elicit grooming from the animal in the mirror (Hughes, 1978).

The potential value of MIS as a technique in primate psychology was advocated by Yerkes and Yerkes (1929), who wrote: 'Response to mirror image is significant alike in studies of social relations, self-consciousness, and aspects of intelligent adaptation .... Evidently there is need of further development and utilization of the method in displaying or demonstrating, if not also in analyzing, the social behaviour of the ape' (p. 139). Foley (1934, 1935) employed MIS in an early study of an isolation-reared rhesus macaque (M. mulatta). He felt that when the infant was first tested, at 47 days, it did not distinguish between the reflective surface of the mirror and the reverse, nonreflective side, since it attempted to cling to whichever side was presented. At 117 days MIS elicited lipsmacking (termed 'mouthing'), vocalization, and defecation. These behaviours were not quantified. On one occasion the monkey as a juvenile was observed to lunge at its reflection in a pane of glass. Cole (1963) documented approach, withdrawal, and facial expressions (not quantified) in pigtail macaques (M. nemestrina) upon presentation of a small mirror, and includes a photograph of an animal grasping behind a mirror.

Some detailed information about the social responses of squirrel monkeys (Saimiri sciureus) to mirrors was presented by MacLean (1964). The elicited genital display was described, as was a difference between

two subspecies of squirrel monkey in the propensity for displaying toward the mirror. In the high-responsive subspecies, MIS elicited penile erections on 29 out of 30 2-minute trials; latency to respond was less than 5 seconds on 26 trials; and vocalizations occurred on 26 trials. Scores for the low-responsive subspecies were much less impressive. MacLean considered mirror tests useful for detecting effects of brain lesions on visually mediated sexual and aggressive behaviour. No direct comparisons with live stimuli were reported. Kaplan (1977) noted differences in form of the mirror display by squirrel monkeys differing in sex, age (infant or adult), and rearing condition (mother-reared or surrogate-reared).

Genital displays could be elicited in squirrel monkeys by a mirror only 1.5cm.^{2}, in which an animal could only see the reflection of one eye (MacLean, 1964). It may be noted that the effects of different sizes and arrangements of mirrors on behaviour have never been systematically investigated, although a call for such research with regard to the effects on induced self-awareness in humans has recently been made (Buss, 1980). Monkeys have been reported to respond to small scraps of mirror, reflections in windows and water, and to full-length mirrors, but controlled manipulation of mirror dimensions are extremely rare.

In exploratory studies with patas monkeys, (Erythrocebus patas), Hall (1962) used both a small hand mirror and a full-length mirror. He also did some pilot work varying the quality of the image, but unfortunately there are no data on this aspect. The two juvenile patas tested were very interested in the hand mirror, touching and licking the surface, reaching behind it while holding it in one hand, and looking indirectly at objects in the environment via the mirror.

They investigated the mirror for the entire duration of the first 5-minute presentation, dropping to just over 60% of the fifth (daily?) presentation. The two adults tested were both startled on discovering a mirror in their foodbowl. The adult male in particular avoided the mirror, and yawned excessively, indicating tension. Both adults were 'agitated' by a full-length mirror outside their home cages, which was moved toward them. Self-scratching increased markedly.

Hall's habituation curve for the yawning response represents a rare instance of quantification of a specific reaction to MIS observed over repeated tests. No live comparison stimuli were used. Gallup (1971, 1975) stated that male patas yawned about twice as much and for longer to MIS as to an unfamiliar live male in daily 10-minute tests, but no other details were given.

A mirror was presented as a 'fear-producing stimulus' by Spencer-Booth and Hinde (1969) during tests of individual behavioural characteristics in rhesus monkeys. Twelve-month-old isolate monkeys spent longer in a filter cage adjacent to a mirror than did socially-reared controls, and touched the mirror sooner. Since isolate monkeys are often considered fearful (see Chapter 2), these findings suggest that multiple features of MIS should be taken into account during tests, e.g., novelty, complexity, and predictability of the image's actions.

Richards (1972) recorded significant increases in threats, lip-smacking, teeth grinding, urination and defecation in rhesus monkeys presented with a round magnifying mirror; eating, self-grooming, and manipulative play decreased. Individual differences in mirror reactions were apparent, whereas relatively few sex- or dominance-related differences emerged. Richards acknowledged the social overtones in the responses of the subjects. The consequences of using a magnifying mirror rather than a plain surface mirror are not known. No particular

justification was forwarded for mirror tests reported by Stevenson-Hinde et al. (1980), who found that rhesus looked less at a mirror at 2.5 years of age than at 1 year of age. At 2.5 years, lipsmacking to the reflection diminished rapidly over two tests, whereas it persisted at 1 year. In these studies, MIS was simply one of a number of tests used, and there was no particular interest in, or discussion of, the elicited reactions.

MIS is reported to support instrumental responding in monkeys, for example by Gallup (1966) in macaques, and by MacLean (1964) in squirrel monkeys who displayed toward their reflections. Using an operant paradigm, Gallup and McClure (1971) compared preferences for MIS or a live conspecific in wild-born and surrogate-reared rhesus monkeys. During five daily 2-hour sessions, wild-born subjects consistently pulled longer on a chain to produce a view of a live conspecific than for MIS. Only three out of ten surrogate-reared monkeys learned the task, but these three preferred the mirror to the conspecific. A subsequent 1-hour test on each surrogate-reared animal confirmed a visual preference for MIS over the live stimulus animal, and social responses were 7 times more common toward the mirror, although these were much less frequent than passive gazing. Unfortunately no wild-born control group was run in this second experiment. The finding of greater attraction toward MIS in isolate rhesus compared to socialized controls by Gallup and McClure (1971) agrees with that of Spencer-Booth and Hinde (1969). Since preference measures are known to be influenced by the subject's motivational state (e.g., Chamove, 1978; Mitchell, 1972; Section 1.5), recording of responses which are good indices of motivational states would be useful.

In a series of experiments investigating self-recognition in olive baboons (Papio anubis), Benhar et al. (1975) also employed a

mirror image reinforcement technique. Two individually housed baboons were enclosed in darkness by placing a large box over their cages. A lever press by a subject would result in its cage being illuminated for 30 seconds. The baboons responded more frequently in sessions when MIS co-occurred with light-on reinforcement. Another procedure was to provide the baboons with a choice of two levers, one resulting in MIS, the other producing a view of another baboon in an adjacent cage. This latter stimulus condition was created using a one-way mirror arrangement. Over several weeks of testing, both subjects responded more on the MIS lever than on the live stimulus lever. However, even when the target monkey was removed, the pattern of lever pressing remained the same, so it is conceivable that level of illumination was a contaminating factor in this procedure. Once again, the basis of the reinforcing effect of MIS was not discussed by Benhar et al., and social responses to the mirror and conspecific were not examined.

The macaque species used in the present study, namely the stumptail (M. arctoides), was studied in detail by Bertrand (1969), who provided much useful descriptive invormation on the species' behaviour patterns, if little in the way of quantitative data. Bertrand carried out some informal experiments using mirrors:

> Each captive group in Calcutta was given one mirror hanging from a string for 1 h. The mirror was round, with a diameter of 30 cm. The monkeys treated it partly as another monkey, and partly as an object. They might look at their own image with a straight face or threaten or greet it. Most individuals would also go behind the mirror, and some, while holding it with one hand, would sweep the air behind it, as if they wanted to find the animal behind.

> They would also sniff their reflection and touch it. They also manipulated the mirror, bit it, licked it, and tried to tear it apart, as they did with other objects. I observed the same reactions, including the gesture of sweeping the air behind the mirror, in liontail, rhesus, pigtail, Japanese, and Barbary macaques, in mona and putty-nosed monkeys, and in my pet gibbon (p. 150).

Bertrand was interested in whether stumptails could self-recognize. To investigate this, she gave two animals free, joint access to a large mirror for four days. Some habituation to the mirror occurred, although some social responses continued to occur; it seemed clear that the monkeys did not recognize themselves. One of Bertrand's stumptails was also seen to threaten its reflection in a pool of water.

The principal investigator of self-recognition in nonhuman primates has been Gallup, whose methods were described in Section 1.4. In the 1970 study, unlike chimpanzees, macaques gave no indication of self-recognition, but were reported to persist in responding socially toward the mirror. Mirror experience was extended over a 5-month period in a young M. fascicularis. During this time casual observations detected only 'gradually diminishing patterns of social behavior' to the mirror, and no evidence of self-recognition (Gallup, 1977b). A dye test after over 2,400 hours of mirror exposure yielded negative results. In fact, the monkey 'appeared oblivious to the red marks, and although visual attention appeared to increase slightly her orientation to the reflection remained unchanged, with continued overtones of social behavior (e.g., grimacing, lipsmacking)' (p. 283).

Berhar et al. (1975) also dye tested baboons for self-recognition in a mirror, and obtained negative results. For example one animal

'continued to behave as if nothing had happened, not paying any attention whatsoever to the red spot' (p. 203). One procedure involved an experimenter interacting with a baboon, in front of a mirror, for seventeen sessions. Dyeing the animal's head blonde did not affect its behaviour. On seeing its reflection after the hair on its head had been shaved off, the baboon was startled and submissive. None of these responses were quantified. A final dye test proved negative.

In the early stages of the present study I also conducted an informal experimenter-monkey interaction experiment involving a mirror. Twenty-one daily sessions of between 30-60 minutes were carried out. A group-living, adolescent female stumptail sat in my lap about 1 metre from a 96 $cm.^2$ mirror. I unsuccessfully attempted to train her to respond to the word 'Go' by touching her head, using a moulding procedure which involved placing her hand on her head after the command and then rewarding her with food or juice. I attempted to keep her looking at the reflection, and would occasionally groom her explicitly in front of the mirror. She was also allowed to explore the small room for 2-3 minutes twice per session, to relieve the monotony of training.

While training was in progress, although the monkey often regarded the reflection, it seemed that she often deliberately avoided looking at it. When released, she would sometimes approach the mirror with a pout face, touch the reflection, and then engage in self-grooming. After 3 weeks of training, it was clear that the mirror continued to possess some social properties for the animal. Two brief extracts from diary notes are illustrative:

> 29.9.78 Day 15. One time when she walked away from me, she began behaving very aggressively toward the reflection,

screaming as well as lunging toward it, while trying to enlist my support. She then began aggressing against her left hand. Because she was so aroused, I terminated the session after 40 minutes.

30.9.78 Day 16. Some threats, as usual, today, but much less intense than yesterday. There were prolonged bouts of grooming in front of the mirror, and a spell of licking the surface of the mirror. With respect to training, she occasionally left her hand on her head after the trial, and sometimes took it off her head and looked at it. Twice she spontaneously put her hand on her head while looking at the image. On one occasion, this resulted in teeth chattering.

A dye test revealed no mark-directed responses at all in front of the mirror.

Social responding by monkeys and gibbons toward a mirror was also documented by Lethmate and Dücker (1973; Lethmate, 1974), who tabulated the presence or absence of specific social gestures in the animals. It should be remembered that 'social responses' are also generally reported in chimpanzees and orangutans upon initial presentation of a mirror. However, whereas in these great apes social responses are soon replaced by actions indicative of self-recognition, in monkeys they persist (see Figure 1).

In an extension of the MIS paradigm to investigate self-recognition, Gallup et al. (1980) (a) presented rhesus cagemates with paired access to a mirror, and (b) commenced MIS with subjects at the unusually young age of 5 months. Since this report is Gallup's most elaborate in terms of data presentation and methodological variation, it is considered here

Figure 1. Mirror image reactions in juvenile stumptail macaques. Top: A juvenile female approaches exhibiting an affiliative, 'pout' face. Bottom: Visual exploration of the reflection.

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Figure 1 contd. Top: An affiliative response to the image. This expression is sometimes accompanied by 'weaving' and 'dodging' movements. Bottom: A young male explores the image, contacting the mirror surface.

Figure 1 contd. Top: An affiliative response to the image. This expression is sometimes accompanied by 'weaving' and 'dodging' movements. Bottom: A young male explores the image, contacting the mirror surface.

Figure 1 contd. Top: Affiliative response to the image. In laboratory-reared stumptails, this expression is often accompanied by a self-clutch. Bottom: Response of a Mirror-Perspex reared juvenile female (see following chapters). This animal often responds to mirrors by opening her mouth wide, in a non-threatening manner.

Figure 1 contd. Top: Affiliative response to the image. In laboratory-reared stumptails, this expression is often accompanied by a self-clutch. Bottom: Response of a Mirror-Perspex reared juvenile female (see following chapters). This animal often responds to mirrors by opening her mouth wide, in a non-threatening manner.

in some detail. The first experiment involved providing a mother-infant rhesus pair with MIS for twelve consecutive weeks, during which time their interest in the mirror was monitored. At the end of 12 weeks, the animals were anesthetized and dye tested individually, then together. Initially it was found that mirror-viewing time of both subjects remained fairly stable after dropping below the level of the first week. The mother regarded the mirror 3-4 times longer than did the infant, and this ratio also held for frequency of 'social responses' toward the mirror. The mother, in particular, 'showed a continuing tendency to respond socially to the mirror which lasted for the entire 12-week period. Neither animal showed any evidence of self-directed behavior in response to the mirror' (p. 215). Whereas social responses in both animals increased during dye tests, no self-recognition was evident. Grooming of the marked partner's head occurred when the animals were re-united.

A procedural consideration with this study is that agitation resulting from separation in the individual tests, and intensified mother-infant interaction in the second test could have caused some neglect of the dye marks on the animals' own heads. Another possibility is that the included procedure of marking the animals on the abdomen, to confirm that they would respond to freely visible marks, might also have distracted attention from the marks on the head. Before the Gallup et al. (1980) study was published, I carried out an informal experiment which involved <u>sequentially</u> marking a monkey on different parts of the body, gradually progressing toward the head. At 2-day intervals, while the monkey was housed with a large mirror outside its cage, its hands were dyed, then its forearms, upper arms, shoulder and neck, face, and finally the head. A rhodamine B, liquid dye was used. After two days most of the dye had disappeared, so the animal did not respond to old

marks. The animal intensely investigated the marks, sometimes while shifting his gaze from himself to the mirror image, but the marks on the head were never touched. The fact that a macaque's prognathous muzzle is directly visible can account for the responses to the facial marks. Furthermore, the marks were applied without anesthetic, yet even this clue did not encourage the subject to investigate marks on the head.

The second experiment by Gallup et al. (1980) was very similar to the first, except that a pair of 5-month old cagemates was used. One notable, unexplained difference was that mirror viewing times of these infants were consistently higher than in the mother-infant pair in Experiment 1. Frequency of social responding to the mirror fell to almost zero after 4 weeks. No mirror-guided self-directed behaviours were observed, either during the 14 week exposure period or the dye test.

In describing work done in 1968, Marton (1974) seems to suggest the presence of self-recognition in rhesus monkeys. This conclusion was based on the observation of behaviour changing from social responses to self-grooming in front of the mirror, while monitoring the simultaneous movements of reflection. Of course such behaviour would not satisfy the criteria of self-recognition adopted in more recent research in the area.

The tendency of monkeys to react to MIS as through they perceived the reflection as a conspecific has resulted in the utilization of MIS to simulate a social encounter. One such study (Lipp and Hunsperger, 1978) tested marmosets (Callithrix jacchus) with hypothalamic implants, in visual isolation, and in a polygonal cage with mirror walls. Brain stimulation which elicited only a vocal threat in an isolated animal would cause the same animal to attack its mirror image. The behaviour of the marmoset toward its reflection in the absence of brain stimulation

was not reported, nor was the response to MIS compared with reactions to live conspecific stimuli.

A large mirror was used by Zumpe and Michael (1978) to assess the effects of the presence of conspecifics on sexual and aggressive behaviours in heterosexual pairs of rhesus monkeys. By placing a large mirror outside the cage, it was possible to obtain a considerable recovery in copulatory activity, after sexual behaviour in the pair had stabilized at a low rate. Also, redirected aggression (presumably toward the mirror) increased dramatically in both animals when the mirror was introduced. The authors felt that sexual behaviour was increased in mutually habituated animals by 'reintroducing agonistic tension into the sexual situation' (p. 39). Of course without additional information several questions remain regarding these findings. For example was the male sexually aroused by the novel (mirror image) female, resulting in him exploiting the available cagemate? Or was the sight of an unfamiliar (mirror image) male responsible? What effects would live conspecifics of various age-sex classes have in a similar situation? Our current knowledge regarding the social psychological effects of MIS in monkeys is insufficient to satisfactorily explain how mirrors affect animals in the ways they do. However, from the research reviewed above, it should be clear that to characterize MIS as simply giving 'the illusion of other monkeys', or to state that MIS 'mimics the presence of conspecifics' is adequate at only a very elementary level of analysis.

The youngest nonhuman primates formally tested with MIS appear to be rhesus monkeys in a study by Kenney et al. (1979). They compared the development of two facial expressions, namely lipsmacking and grimacing, in response to two stimuli, namely a human face and MIS.

The animals, all individually housed, were tested from the first week of life to Week 12. A trial consisted of a 15-second presentation of either an experimenter's face, or a mirror, during which time the presence or absence of each facial expression was recorded. In general, the results indicated low responsiveness to both stimuli in the first two weeks, followed by sharp increases in both responses until Week 5. At this time lipsmacking began to decline, while grimacing continued to increase. MIS elicited approximately twice the frequency of lipsmacking as did the human face, and approximately one quarter the frequency of grimacing. The mean age of the first response was lower to the mirror than to the human face. Other than documenting the occurrence of lipsmacking toward a mirror in very young, individually housed rhesus infants, this study adds little new information about MIS reactions in monkeys, since the measures used were gross. As might be expected, a comparison of the development of responsiveness to MIS and to a live conspecific has not yet been attempted.

The final report to be described in this section provided an empirical demonstration of the ability of rhesus monkeys to correctly respond, non-socially, to environmental information reflected in a mirror. Subjects were trained on a Wisconsin General Testing Apparatus, to perform a colour discrimination which required the subject to pull on one of two cords (Brown et al., 1965). After an initial tendency to reach directly toward the mirrored cues, the monkeys learned to pull the correct cord while monitoring performance in the mirror. From the description and photograph presented by Brown et al., it appears that the monkeys could see only the discriminanda and cords in the mirror; not themselves.

1.10 Critical Overview of Monkey MIS Research

Three summarizing statements are possible from the research described in the previous section: (a) Monkeys are interested in reflections, especially during initial presentations; (b) Monkeys typically exhibit social responses to their mirror images; (c) Monkeys do not appear capable of self-recognition as assessed by the Gallup dye test.

Regarding the first of the above statements, the literature only hints at the possible motivations underlying the interest in a mirror. Various affective states have been invoked in descriptions of responses to MIS, including fear, affiliation, playfulness, and aggression. How these might vary with subject characteristics, or indeed with stimulus characteristics, is not known. This question is related to a major shortcoming of most of the monkey-MIS reports, namely the lack of behavioural detail in most accounts. Gross categorization of the animal's reactions as 'mirror-viewing time', 'mirror-directed activity', or 'social responses' has been the norm, and how the behaviours elicited by a mirror compare to those elicited by other forms of social stimuli has not been investigated to any extent. This state of affairs stands in contrast to the detail presented in a body of research with fish subjects (see Section 1.5).

The scarcity of detailed analyses of mirror-elicited social reactions in monkeys is largely attributable to interest being focused on the question of self-recognition, and the notion of 'social' responses being accepted in the shadow of the more dramatic, negative results of the dye tests. Gallup (e.g. 1968) is certainly aware that MIS should not be uncritically equated with a true social encounter, yet it remains an empirical question to what extent a statement such as 'In all instances, monkeys respond to their own image in a mirror

as though they were in the presence of another monkey ...' (Gallup, 1977b, p. 282) might require qualification.

A satisfactory analysis of the social stimulus properties of MIS in monkeys would also require controlled comparisons of MIS with other types of stimulus, including live conspecifics and cruder approximations, e.g., photographs. Most reports include no such comparisons; the equivalence of MIS and true conspecifics is usually either assumed or not considered. Finally, with regard to self-recognition, the conclusion that monkeys might not be capable of this process is based largely on the negative results from the Gallup dye test. Only minor variations upon this technique, and upon the pre-test mirror exposure have appeared. There is adequate scope for modification and extension in this area.

CHAPTER TWO. INTRODUCTION TO THE PRESENT STUDY, AND REVIEW OF LITERATURE ON EARLY REARING IN PRIMATES

2.1 Aims of the Study

The present study was conducted with three main objectives in mind. These were: (a) to carry out an extensive and rigorous study of whether macaque monkeys are capable of recognizing themselves in a mirror; (b) to compare in detail the responses elicited by mirror image stimulation (MIS) with those elicited by other types of social stimuli, with a view to clarifying some perceptual features important in macaque social interaction; and (c) to obtain information on behavioural development in infant stumptail macaques reared under conditions of varying social complexity, using MIS as a social companion. Both Gallup (1980) and Mitchell and Caine (1980) recently expressed interest in a project which would achieve the third objective stated above. These three areas of special interest, and the approaches adopted in the present study, are elaborated below.

1. Self-recognition. In the previous chapter it was noted that previous failed attempts to demonstrate self-recognition in monkeys were characterized by their rather strict adherence to Gallup's original paradigm. Following a period of exposure to a mirror placed outside the home cage, the subject is marked on the head, and its reactions to seeing the altered image are recorded. The present study aimed to extend the mirror image paradigm by introducing four main innovations: (i) Extensive mirror image exposure was commenced at the early age of 2 months. Prior to this study, the youngest animals given MIS before a self-recognition test were 5 months old (Gallup et al., 1980). It seemed possible that by bringing forward the initial mirror exposure to an age at which infants rapidly increase locomotor and playful

activities, attention to the reflection might be enhanced. (ii) The previous MIS duration record of over 5 months (2,400 hours) (Gallup, 1977b) was extended in the present study, with regular removal of the mirror to reduce habituation effects. Thus prolonged exposure time was emphasized. (iii) The common technique of leaving the mirror outside the animal's cage was replaced by securing mirrors inside the cage (also recently suggested by Gallup, 1980). This ensured that the animal had an unobstructed view of the reflection, and could freely contact the mirror surface. (iv) In order to further enrich experience with the mirror, instead of the usual arrangement of a single mirror producing a single image, two mirrors were arranged so as to form a right angle in one corner of the cage. Such an arrangement meant that the animal could see up to three reflections of itself simultaneously, each from a slightly different orientation.

2. Social behaviour analysis. Almost all accounts of mirror image reactions in animals refer to social behaviours directed toward the image. It was a major aim of this study, following some of the work on responses of fishes to MIS, to compare in some detail monkeys' responses to MIS with responses to other social stimuli. This aim gave rise to two concerns, namely the range of stimuli to be used for comparison purposes, and the degree of detail desired in analyzing the behaviours exhibited toward the stimuli.

Firstly, there was the question of which stimuli MIS should be assessed against. Among the stimuli examined in fish studies are; an empty adjacent tank; stationary 2-D cutouts; stationary and moving 3-D models; mirror; a displaying conspecific on the reflecting side of a one-way mirror, constituting an opponent whose display sequences and orientations are independent of the subject's; a conspecific behind

Perspex, and a fully accessible conspecific (see e.g., Thompson, 1963; Figler, 1972; Dore et al., 1978; Meliska and Meliska, 1980). The present study employed some of these situations, as well as some others. At different stages of the study, MIS was compared with an empty cage, a moving colour film of a conspecific, coloured slides of conspecifics, a familiar or unfamiliar peer behind Perspex, and a fully accessible peer. This range of stimuli seemed adequate for a preliminary analysis of how monkeys interpret MIS, and how they respond to social stimuli of varying approximation to a fully accessible conspecific. Of course it is not an exhaustive range of relevant stimuli.

Secondly, it was clear that behavioural analysis in the present study had to improve upon existing primate MIS reports in describing and quantifying social responses. To label behaviours simply as 'mirror-directed' or 'social' provides only a crude picture of how monkeys perceive MIS. As in some fish research, both frequencies and durations of behaviours were recorded in the present study. However, the wider range of social behaviours exhibited by primates also required to be taken into account. Submission, exploration, play, dominance, affiliation, and sex could potentially all be observed, so all were recorded in the present study.

In addition to adopting a more comprehensive range of categories, the present study also examined MIS reactions more thoroughly than previous studies by (a) recording regularly over a long period of time, and (b) considering extra parameters, such as bout lengths of specific behaviours, and variability in behaviours.

3. MIS as a social companion during rearing. On considering the literature which indicated strong tendencies in monkeys to direct social behaviours toward mirrors, the question occurred as to how adequate a social partner a mirror would be for an infant monkey (see

also Gallup, 1980; Mitchell and Caine, 1980). The most relevant existing research (Pratt, 1969; Sackett, 1966, 1973a) had involved presenting pictures of monkeys and inanimate objects to infant isolate rhesus macaques, by projecting them onto a wall of their isolation chambers. Pictures of monkeys (e.g., threats, infants) were found to elicit more behaviours such as vocalization, play, and exploration, than did non-monkey control pictures. However, during social tests with live conspecifics beginning at 9 months of age, 'picture isolates' were virtually indistinguishible from total isolates, both groups exhibiting high levels of disturbance, e.g. self-clasping, stereotyped rocking, and few social interactions of any kind. These two isolate groups were more disturbed than 9-month partial (wire cage) isolates, who were in turn more disturbed than socialized control animals. It therefore appeared that visual social input in the form of pictures of conspecifics could elicit innately programmed social responses from infants, but that this form of social stimulation was insufficient to prevent development of the typical rhesus isolation syndrome.

A similar type of experiment using MIS instead of slides would differ from the picture isolation method in several potentially significant ways. Firstly, MIS would provide an almost continually present source of social stimulation, in contrast to the slide availability schedule of 2-5 minutes per day reported by Sackett (1966). Secondly, a reflection would constitute a long-term partner perfectly matched for sex and developmental status of the subject, unlike the variety of age-sex classes of conspecifics depicted in the slides shown to the picture isolates, some of which actually caused disturbance in the animals. Thirdly, a mirror image would constitute a richer, more complex, moving, and more life-like social stimulus than could pictorial

stimuli. Although picture isolates were also exposed to moving films of conspecifics, the sessions were brief and experimenter-controlled. Furthermore, the movements and postures of the 'social partner' in the mirror would be dictated by the subject, a worthwhile consideration since socially deprived infants are known to prefer relatively low, predictable levels of stimulus complexity (e.g., Gallup and McLure, 1971; Sackett and Ruppenthal, 1973).

Interest in the question of how well a mirror image could serve as a social partner during rearing, and whether mirror-reared animals would differ from peer-reared animals in socio-emotional development, was further strengthened by the fact that there was very little information available regarding behavioural development in differentially reared stumptail macaques. The existing literature pointed toward possible differences between stumptails and the much studied rhesus (e.g., Chamove, 1973b; Davis et al., 1968). These reports, and personal observations of laboratory-reared stumptails, indicated that the question merited further investigation. The following section presents a short, but necessary review of the literature on the effects of differential early experiences on behaviour of nonhuman primates. Issues in the area which the present study seemed most concerned with are indicated.

2.2 Review of Early Rearing Experiences in Nonhuman Primates

Since the literature on the effects of varying social experiences in infant primates is so large, the present discussion selectively focuses upon studies of particular relevance in the context of the present study; otherwise the reader is referred to review articles.

The method of denying an infant monkey conspecific social experience during infancy, and assessing subsequent behaviour, is not new (e.g., Foley, 1934, 1935). Modern systematic research, however,

stems from work done at Wisconsin (Harlow and Zimmermann, 1959), assessing the behaviour of infant rhesus monkeys housed only with inanimate 'mother' surrogates. Such infants showed a strong preference for remaining in contact with a cloth-covered wire 'mother', rather than a bare wire cylinder of identical dimensions. Furthermore, in a threatening situation, such as an unfamiliar environment, infants would cling to cloth surrogates, but would not seek contact from a wire mother. In the latter condition the infants would exhibit marked withdrawal from the environment, and engage in self-huddling and stereotyped rocking, whereas the cloth mothers imparted some security to the infants, so that they were less distressed. Both of these surrogate-rearing regimes, however produced monkeys that were severely abnormal in later social behaviour.

Harlow's early studies (1962; Harlow and Harlow, 1965) stimulated many experiments concerned with early environmental influences on behaviour in primates. It is convenient to consider these studies as being in one of two categories, namely those concerned with identifying stimulus features involved in affectional systems, and those concerned with the consequences of missing certain types of experiences. These two strands of research are outlined separately below, although it is often difficult to maintain the distinction between them.

1. Stimulus features involved in social interaction. Harlow's experiments mentioned above, demonstrated that contact comfort appeared more important in a rhesus monkey's affiliative behaviour toward an attachment figure, than was nursing. The latter variable was not entirely unimportant, however, since a cloth surrogate which provided milk was preferred to a non-nurturant cloth surrogate. Later investigations of the tactile basis of attachment formation defined more clearly the qualities required in tactile surfaces to enable them to elicit filial responses (Harlow and Suomi, 1970).

Studies of the importance of visual cues in attachment formation in nonprimate mammals (Cairns, 1966) suggested that vision might also play a substantial role in attachment in primates. Sackett's work (1966), discussed earlier, had demonstrated that certain visual configurations could elicit social responses from naive infant monkeys. Subsequent experiments (reviewed in Sackett and Ruppenthal, 1974) indicated that visually triggered innate releasing mechanisms also operated in the development of affectional systems. For example it was found that infant macaques possessed an apparently innate propensity to approach an adult female conspecific in preference to nonconspecific females or a conspecific adult male. Early experience with humans (Sackett et al., 1965) or with an alien macaque species (Chamove and Harlow, 1975), could instill a preference for nonconspecifics, although later conspecific social experience could reverse this. Experiments of this type suggest that attachment formation in infant monkeys depends upon an interplay between pre-programmed sensitivities toward certain aspects of the environment, and learning processes which result in affiliative behaviours being increasingly directed toward stimuli which are particularly salient in the infant's early life. Auditory (Sackett, 1973a) and olfactory (Kaplan et al., 1977) mechanisms probably also operate in similar ways.

A familiar cloth surrogate, either fully or only visually accessible, reduces disturbance caused to an infant monkey by placing it in a novel environment, compared to an unfamiliar surrogate or nothing (Mason et al., 1970). Tactile contact is most effective in this regard, suggesting that contact comfort is a more powerful facet of the infant's attachment than is visual contact. To date, however, attachment to a salient social object that is only visually available has not been assessed in primates. The mirror-rearing condition planned for the present study

seemed potentially informative in this respect.

2. Consequences of early social restriction. It was clear from the early studies (e.g., Harlow and Harlow, 1962) that an inanimate, cloth surrogate mother was not sufficient for social behaviour to develop normally in infant rhesus. Reports addressed the extent of behavioural pathology caused by rearing for the first 6 or 12 months in isolation from other animals. Isolates were identified as being grossly impaired in several aspects of social behaviour (e.g., Mason, 1960, 1961), and in response to novelty (Mason and Green, 1962). They also exhibited abnormal behaviours in their home cages (Cross and Harlow, 1965). Generally, isolates could be distinguished from socially reared control animals by their high levels of stereotyped movements and abnormal postures, inappropriate levels of fear and aggression, self-directed activity, and their general retardation in adapting to novel situations (general reviews: Sackett, 1970; Mitchell, 1968). Similar research on chimpanzees reached similar conclusions, but with the qualification that the isolation syndrome was rather less severe and pervasive in chimpanzees than in rhesus monkeys (Davenport, 1979; Davenport and Rogers, 1970; Mason et al., 1968).

Studies have also focused on specific behavioural abnormalities resulting from social restriction, such as impaired sexual performance (Missakian, 1969; Testa and Mack, 1977), abnormal levels of aggression (Møller et al., 1968), self-aggression (Gluck and Sackett, 1974), inadequate maternal behaviour (Arling and Harlow, 1967), deficient communicatory skills (Miller, 1967), abnormal patterns of food and water intake (Miller et al., 1971), impaired reactions to noxious stimulation (Lichstein and Sackett, 1971), intellectual deficits (reviewed in Gluck, 1979), and the persistence of abnormalities into adulthood (Fittinghof et al., 1974; Mitchell, 1968; Suomi et al., 1971). These

researches show beyond doubt that the extreme condition of isolation produces marked and persistent behavioural pathology in rhesus macaques. In attempts to better identify the critical types of input which are lacking in the isolation condition, several different social rearing regimes were developed. For example the role of peer relationships in young monkeys was investigated by rearing some infants only with their mothers, i.e., without access to peers (Alexander, 1966). Similarly, elimination of adult socializing influences on infants was achieved by rearing infants only with other infants (Chamove, 1973).

Several hypotheses have emerged to account for some of the behavioural effects observed in socially deprived primates, some emphasizing emotionality or arousal factors (see e.g., Fuller, 1967; Mason, 1968), physiological aspects (e.g., somatosensory deprivation, Prescott, 1975), or retardation of normal social development resulting from the absence of certain types of social experience at sensitive stages (discussed by Clark, 1968). Different hypotheses about the nature of the effects have resulted in a variety of therapeutic procedures being employed to reverse the deficits, but these need not be discussed here.

The 'isolation syndrome' discussed so far comprises a number of aberrant behaviour patterns which have been documented in rhesus monkeys. It is not an invariant consequence of isolation rearing, as borne out by the chimpanzee studies mentioned earlier. Recent research has also revealed that closely related macaque species also differ in the severity and pattern of the isolation syndrome. Sackett et al. (1976) reported that pigtail macaques develop a much milder isolation syndrome than rhesus, assessed both in the home cage and in other environments. Both social and nonsocial behaviours differentiated the two species. Except for one short report by Riesen et al. (1977),

there are no published data on stumptails detailed enough to permit a comparison of behaviour in experimentally reared stumptails with that in other macaques. Preliminary consideration of this issue suggests that, among other differences, rhesus isolates are prone to high levels of stereotypy, and severely impaired social performance, while socially restricted stumptails are susceptible to developing prominent self-aggression, few stereotypies, and seem more able to rapidly adjust to social housing (Anderson and Chamove, 1980; Chamove and Anderson, 1981). The present study, therefore, also asked whether more empirical support could be found for a rhesus-stumptail difference in response to early social restriction.

2.3 Plan of the Present Study

In order to study the three issues listed at the beginning of the chapter, namely self-recognition, social behaviour, and behavioural development, using MIS, the following plan of research was designed. Monkeys reared only with a mirror as a social companion would be compared against peer-reared monkeys on the dimensions mentioned above. By 'behavioural development' was meant the course of development of various activities such as locomotor activity, exploration, and play. Abnormal behaviours, such as self-aggression, stereotypy, and unusual posturing were also to be monitored. 'Social behaviour' analysis required detailed comparisons of behaviour patterns directed toward different social stimuli, e.g., mirror or peer. Both general behavioural development and social responses would be assessed during home cage tests, and in subsequent tests in other environments.

In addition to simple mirror-only and peer-only conditions, the present study also examined two compound rearing conditions. For example one question of interest was whether behaviour toward a mirror

would vary markedly between mirror-only, and peer-experienced animals. Therefore MIS reactions of animals with experience of both types of stimulus were examined. Peer-plus-mirror experienced animals were also considered potentially interesting since Gallup et al. (1971) had found that only socially experienced chimpanzees, and not isolation-reared chimpanzees, learned to self-recognize, although a mirror-only rearing condition has never been studied in chimpanzees. A strong case could also be made for comparing responses to a mirror with responses to a peer behind a transparent partition, since the latter condition more closely resembled MIS with regard to tactile restriction than does a fully available peer. For this reason animals with experience of both MIS and a conspecific behind Perspex were also included.

The various considerations mentioned above led to the formation of four experimental rearing conditions in the present study: (1) animals reared only with a mirror as a social companion; (2) with a mirror and additional experience of a peer behind Perspex; (3) only with a peer; and (4) with a peer plus additional experience of a mirror. These four conditions can be collapsed into two main ones: primarily mirror-reared (i.e., with never any physical access to another monkey), or primarily peer-reared. The rearing conditions are fully described in the following chapter.

The research to be described has been divided into two major sections. Chapters 3, 4, 5 and 6 deal with the behaviours of the subjects in their home cages, including social behaviour and general behavioural development. Chapters 7 and 8 report experiments concerning self-recognition, and social and nonsocial responses in a variety of stimulus situations. The findings are discussed in Chapter 9.

CHAPTER THREE. METHODS: HOME CAGE BEHAVIOUR

3.1 Subjects

Eight infant stumptail macaques served as the principal subjects in the study, with two additional animals being observed. All infants were born in the University of Stirling Psychology Primate Unit between 7 June, 1978, and 23 April, 1979, to multiparous group-living females. The infants were separated from their mothers during the first week of life; the following procedure being employed: The mother, carrying the infant, entered a transport box and was taken from the colony to another room. The mother was given an intravenous injection of a general anesthetic ('Saffan', 1-1.5 ml.), which caused her to lose consciousness within a few seconds. The infant was quickly taken from the mother, carried in a diaper to another room weighed, placed in an incubator, and offered warm milk from a bottle. Thereafter, the infant was held up to the bottle at hourly intervals, until self-feeding was achieved, usually within 12-24 hours (see Chamove, 1975, 1981). The room in which the incubator was situated contained no other monkeys, and disturbance to the infant was minimal. At night, illumination was provided by a 60 Watt electric Angle-poise lamp, facing away from the infant. After two to three days, the infant was removed to a pre-experimental cage.

Due to a change in the Primate Unit's neonate management procedure, the first five infants and the second five experienced slightly different procedures after leaving the incubator. The first five subjects were placed directly into individual cages in the room, called the 'nursery', where they were to be housed during the study. The second five infants first spent two weeks housed in individual cages in a smaller room, where temperature could be better controlled. It is unlikely that this

Table 1. Dates of birth, rearing conditions, and weights of subjects.[1]

Subject	Sex	Date of Birth	Principal Rearing Condition	Weights (g) 30 days	60	106	197	346
61	M	7.6.78	Alone	622	840	1375	2130	3065
69	M	12.3.79	Alone	827	954	1330	-	2880
62	M	27.7.78	Mirror	838	1030	1360	2118	2900
63	M	30.8.78	Mirror	878	1125	1495	1905	2910
70	F	13.4.79	Mirror	673	892	1291	1973	2280
71	F	23.4.79	Mirror	847	1130	1570	2200	3000
64	M	14.12.78	Peer	960	1260	1650	2411	3536
66	F	23.12.78	Peer	784	978	1248	2090	3070
67	M	27.1.79	Peer	1021	1368	1673	2540	3176
68	M	31.1.79	Peer	813	1134	1530	2190	2805

[1] Analysis of variance comparing mirror- and peer-reared animals revealed no significant difference in weights between them at any age.

slight variation in early housing affected the infants' development. Table 1 provides details of the subjects, including weight gain during the study. When the subjects reached 2 months of age, their respective experimental rearing conditions commenced.

3.2 Apparatus

1. Housing. The nursery, in which the home cages were located, was a room measuring 5.1 X 2.9 metres, with height 3.7 metres. A two-tiered run of cages, containing sixteen cages in all, ran along one wall of the nursery. Lighting was switched on at 0900 hours, and turned off at 1700 hours, but a small skylight in the ceiling also allowed in some natural daylight. There were no windows. Temperature was maintained between 23° and 30°C.

Three types of home cage were used in the study of home cage behaviour, as follows:

Plain home cage. A plain home cage measured 50.6 X 60 cm, with height 68.8 cm. The front, back, floor, and ceiling were of steel mesh (5 X 2.5 cm), while the two side walls were of opaque white Perspex. A 24 X 28 cm transparent Perspex guillotine door was situated at the front. Each cage contained a water faucet at the back, a food hopper at the front, and one spar running from front to back, 27 cm above the floor (Figure 2).

Mirror home cage. A mirror home cage was identical to a plain home cage, except for two mirrors, each 25 X 60 cm, fixed in the cage to form a right angle at the junction of the back and right cage walls. The mirror surface was protected by a .25 cm layer of transparent Perspex, placed flat against the surface. This mirror arrangement permitted an animal in the cage to observe up to three full-length reflections of itself, and to contact the mirror.

Perspex home cage. A Perspex home cage was identical to a plain home cage, except that one side wall was of transparent Perspex, rather than opaque white Perspex. Two Perspex home cages were placed immediately beside each other, to allow the occupants to see clearly into the neighbouring cage, about 2 cm away.

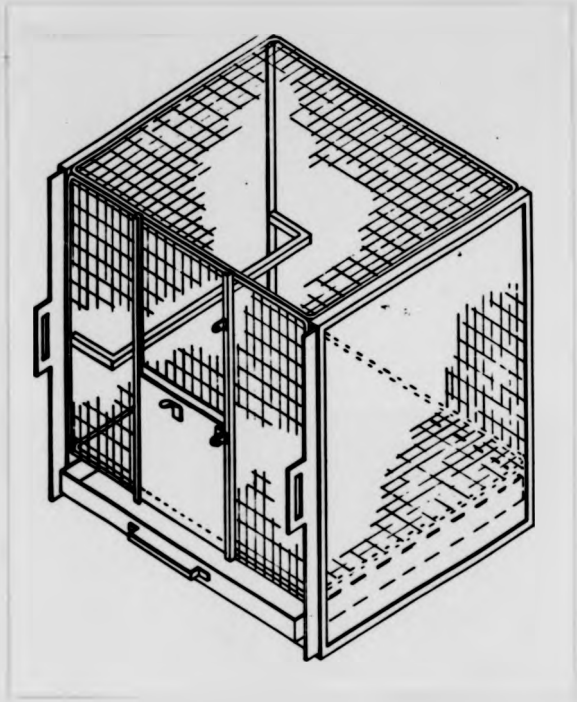
Apart from in the Perspex home cages, which were deliberately employed to permit visual access into a neighbouring cage, animals could not see from their home cages into any other home cages.

Cleaning of the home cages involved removing trays below the cages and immediately replacing them with clean ones. This was done daily between 0900 and 1000 hours. One morning each week, every home cage was cleaned using a power hose, after the occupant had been re-housed in a similar home cage. Cleaning was always completed at least 1.5 hours before testing commenced.

Feeding occurred at 0900 and 1630 hours. Bottles of milk were attached to the cage fronts, and beginning at 110 days of age, monkey chow was put into food hoppers. Bottles were usually taken down from the cages shortly after being emptied by the animals, and always at least 10 minutes before testing.

Every occupant in a cage was allocated one diaper, which was a piece of white cotton approximately 10 X 10 cm (Figure 2). Diapers were removed at feeding times and immediately replaced by freshly laundered ones.

Three months after home cage observations on the first subject had begun, a 2.5 metres high opaque white wooden partition was erected along the length of the nursery, 1.7 metres from the cages. The partition contained two doors, and four 16.5 X 1.5 cm horizontal slits, 1.3 metres from the floor. It was possible to observe the animals in their home cages from behind the partition through the slits, thereby reducing the obtrusiveness of the observer.



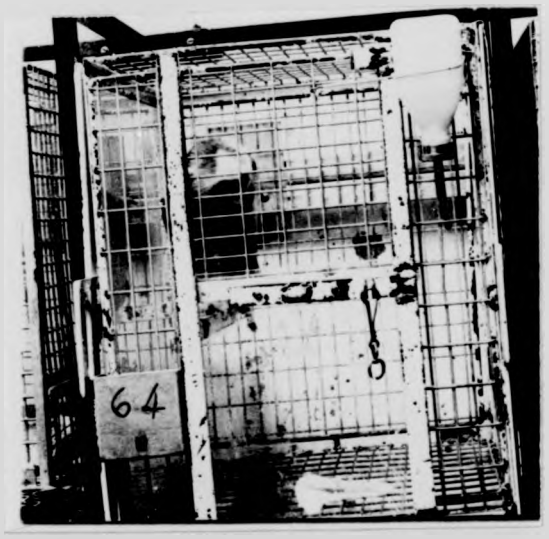
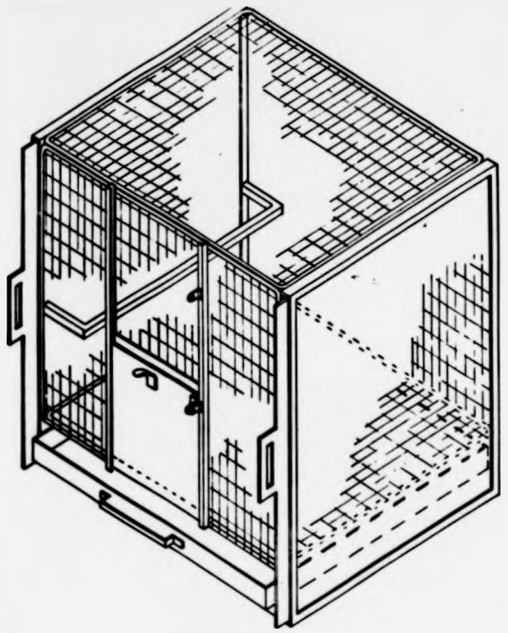


Figure 2. Drawing and picture of a plain home cage. In the picture the infant's diaper is lying on the floor. (Drawing by J. Russell.)



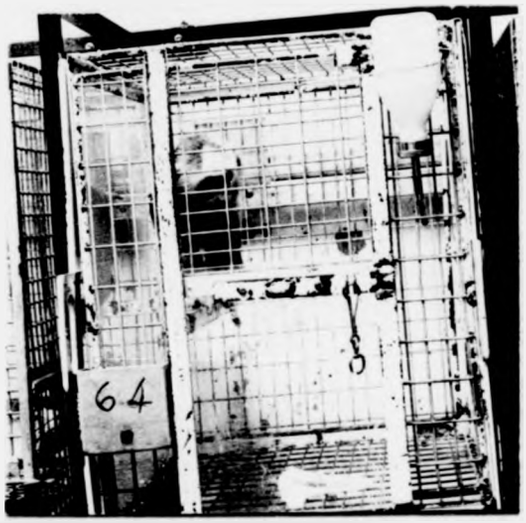


Figure 2. Drawing and picture of a plain home cage. In the picture the infant's diaper is lying on the floor. (Drawing by J. Russell.)

2. Recording apparatus. Two different types of apparatus were employed to record home cage behaviour. General behavioural development was assessed by means of a home cage checksheet. At the leftmost side of the checksheet was a column of the names of the behaviour categories recorded, with a row of cells running across the checksheet for each behaviour. Each cell represented a 15-second interval, and one checksheet accommodated 10 minutes worth of data. Checksheets were attached to a clipboard. The 15-second intervals required for the checksheet procedure were demarcated by a portable National Panasonic tape recorder, which ran a tape made to emit a just audible tone every 15 seconds.

Home cage social behaviour was recorded by means of a 9-key keyboard, 12 X 19 cm, linked to a 'Data Transfer Unit' (DTU), a device which transferred onto paper tape information coded by depressing sequences of buttons on the keyboard (Figure 3). The keys, in a 3 X 3 matrix, were numbered 1 to 9. Every behavioural event which was of interest to the observer was coded in terms of a sequence of three key punches. The first key to be punched referred to the behaviour which the subject performed. The second key punched indicated the object to which the behaviour was directed. The third key indicated whether the subject made physical contact with the object during the behavioural event. For example, if the subject performed aggression involving physical contact against the social partner (e.g., a bite or grab), the sequence 4-1-1 was entered rapidly on the keyboard, i.e., in less than one second, and thus onto paper tape via the DTU. When the subject's behaviour next changed, a new 3-key sequence would be punched, for example 2-3-2 to designate noncontact exploration of the environment. Time, which was coded with the first key-punch, and sequential ordering of the input were also preserved on tape. Thus it

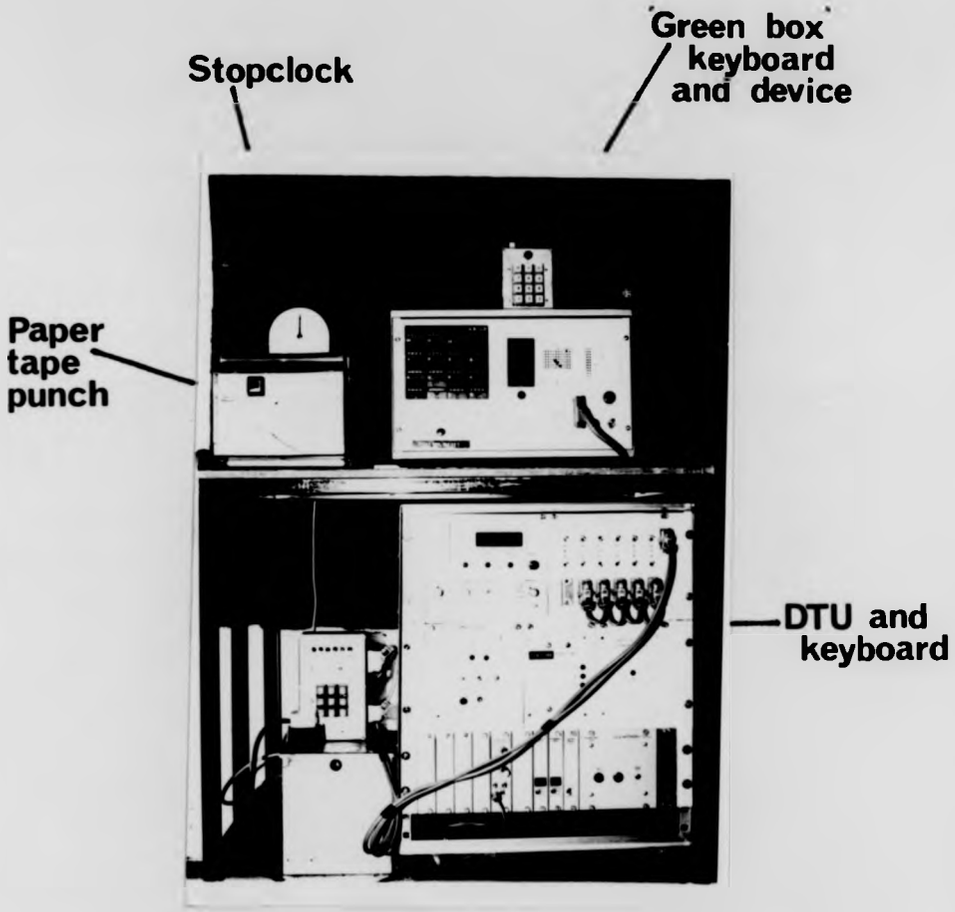


Figure 3. DTU recording apparatus, and 'green box' clock-counter device.

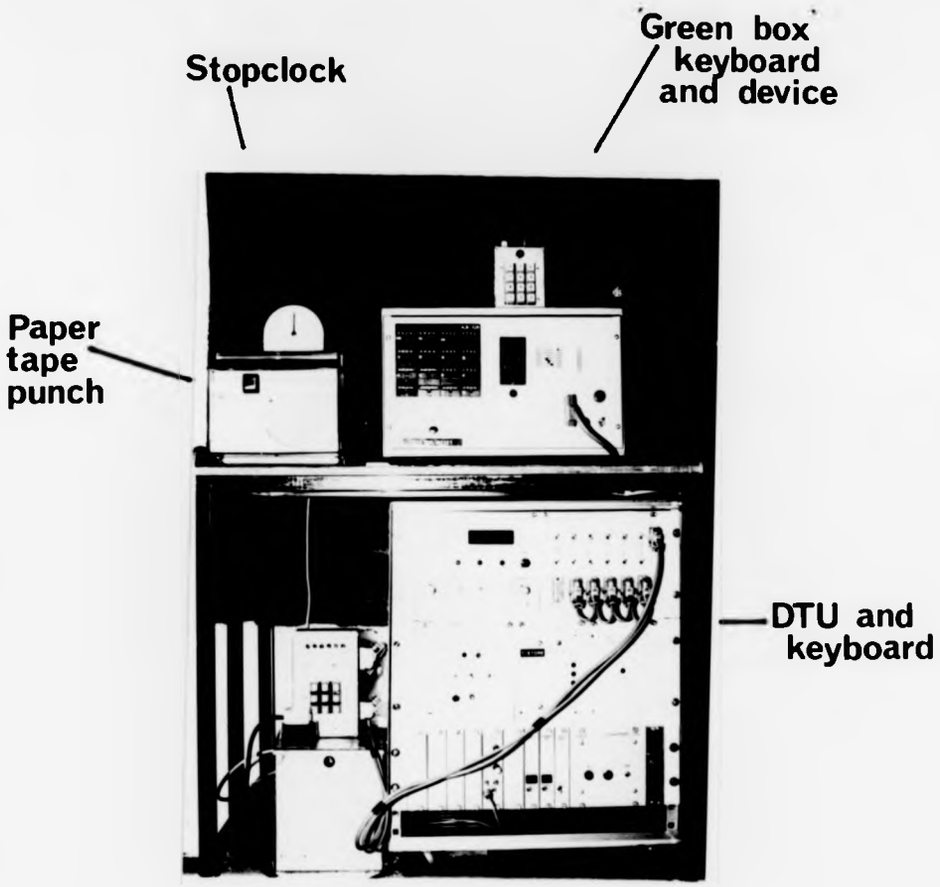


Figure 3. DTU recording apparatus, and 'green box' clock-counter device.

was possible to derive true frequencies and durations of all recorded behavioural events, as well as mean event durations, and latencies of events from the start of a session. All of the above parameters were obtained by submitting each paper type to computer analysis, using the Primate Unit's 'Primate Observational Data' (POD) programme.[1] Appendix 1 contains a sample of the information stored on DTU tape and a POD summary table. Chamove (1974a) has described the utility of such a recording system. The DTU was roughly the same size as a large television set. Along with the paper tape punch, it was mounted on a trolley which could be moved easily.

A small proportion of home cage observations were taken from videotaped sessions. The videotapes were made using a Sony Videocorder camera: Model AVC 3420, and a Sony Videocorder deck: Model 3260 CE. The tapes were played back on a National Video monitor: Model VW 5310E/B.

3.3 Procedure

1. Rearing conditions. On the first Monday following the attainment of 60 days of age by an infant, it was removed from its pre-experimental cage, and placed along with its diaper into a home cage appropriate to its rearing condition. In the case of two infants to be housed together, this occurred on the first Monday following an average age of 60 days being reached. The following five rearing conditions were studied: Alone, Mirror-Only (MO), Mirror-Perspex (MX), Peer-Only (PO), and Peer-Mirror (PM). Descriptions of these conditions follow.

Footnote: 1. POD was written with support from SRC grant B/RG 98910 to A. Chamove

Alone. These two subjects were each housed alone in a plain home cage. They were included in the study because they could not be reared by their mothers and could not be housed with peers due to their dates of birth. They received the same handling and tests as the experimental subjects, although weekend data were not collected for 3 months on the first Alone subject.

Mirror-Only. For 4 days every week: Monday morning until Friday morning, the two MO subjects each lived in a mirror home cage. The The other 3 days (Friday-Monday) were spent in plain home cages, i.e. without mirrors. The plain home cages were situated immediately above or below the MO subjects' weekday mirror home cages.

Mirror-Perspex. Like MO infants, MX infants each occupied a mirror home cage from Monday until Friday. Instead of moving to plain home cages at weekends, however, the two MX animals occupied immediately adjacent Perspex home cages, which allowed them to look at each other through the common Perspex side of the cages. There was a gap of approximately 2 cm between the Perspex home cages.

Peer-Only. From Monday until Friday, the two PO infants were each housed in a plain home cage with one other infant, which was always the same animal. At weekends, PO infants lived alone in plain home cages.

Peer-Mirror. The two PM monkeys each lived in a plain home cage with another animal every Monday to Friday, the social partner always being the same. At weekends PM animals were individually housed in a mirror home cage. The PM condition was the only one which involved physical social experience with a real conspecific, and MIS.

Home cage observations were carried out during 5 months of the rearing conditions described above, i.e., until the animals reached 7 months of age. As far as possible during this period handling by humans was restricted to that involved in the weekday-weekend shifts in home cage conditions, cage cleaning, and weighing, which occurred three days per month. Humans which the subjects saw or contacted wore

white face masks which covered the nose and mouth region of the face, and usually wore either blue boiler suits (technicians) or white laboratory coats (technicians and researchers). The experimenter always wore a mask and white coat.

2. Behaviour sampling. The subjects' home cage behaviours were recorded from Day 1 of their rearing conditions. Both the home cage checksheet and DTU were used with the two main groups of subjects, but the DTU was not used with the two Alone animals. The checksheet procedure involved observing a subject each day for 5 minutes, to obtain modified frequencies of 22 behaviour categories from 2 months to 5 months, and 23 categories from 5 months until 7 months. The categories were concerned with general behavioural development, including the tendency toward self- and environment-directed behaviours, locomotion, play, and abnormal behaviours. Table 1 in Appendix 2 lists the home cage checksheet behaviours and their definitions.

To begin a home cage checksheet session, the observer quietly entered the nursery and switched on the cassette tape recorder, which emitted a brief tone every 15 seconds. He then sat down on a chair in front of the subject's cage, at a distance of 1.5 metres from the cage. He remained quiet and motionless for one minute, before commencing to use the checksheet. Any of the behaviours listed in Appendix 2 which occurred within a 15-second interval was recorded by making a tick in the appropriate cell on the checksheet. The maximum number of times each behaviour could be scored in one 15-second interval was once. At the end of the 5-minute observation, the experimenter stood up, calmly positioned his chair in front of the next subject to be observed, sat down, and again allowed one minute to elapse before commencing the observation. All home cage checksheet observations were completed before the day's DTU recording session began. There was

usually an interval of 10-15 minutes between the end of checksheet observations and the start of the DTU session.

The DTU behaviour categories were aimed at allowing comparisons of social behaviours exhibited toward the different social partners. Eight behaviours, four objects toward which behaviours could be directed, and whether or not contact occured between the actor and the object were recorded using the DTU system outlined in Section 3.2.2. The behaviours and their definitions are given in Table 2, Appendix 2. The four objects were: Partner, which was the peer, mirror image, or conspecific behind Perspex, depending upon the experimental condition; Environment, which was any object other than the partner, observer, or self; Self, which was the subject's own body; and Observer. Of course not all possible combinations of behaviour, object, and contact occurred (e.g.,Sex-Observer).

As pointed out by Chamove (1974a), when using a recording system of the type employed in the present study, it is desirable to construct a hierarchy of possible events, in terms of their relative importance to the experimenter. Thus, when a subject engages in more than one behaviour simultaneously, e.g., Contact Affiliate Partner and Contact Explore Environment, the more important of the two events is scored at the expense of the other. In the present study, where interest was in social behaviours, whenever the subject directed a behaviour toward the social partner, i.e., peer, reflection, or peer behind Perspex, that action was always scored in preference to any concurrent behaviour toward another object. In the above example, therefore, Contact Affiliate Partner would have been entered on the keyboard. Following the object Partner, Environment was given priority, followed by Self and Observer, respectively. With the provision that social behaviours were always scored, Contact actions always took precedence over

Noncontact actions. Finally, a hierarchy of behaviours was constructed, with priority being given firstly to infrequent acts, and then in terms of how much they cost the subject in terms of individual distance (see Anderson and Chamove, 1979). The final ranking of the behaviours was, in decreasing order, Sex, Dominance, Submission, Affiliation, Play, Oral, Exploration, and Other.

To begin DTU testing, the observer wheeled the DTU-laden trolley into the nursery, and spent approximately one minute preparing the apparatus for use. The observer then sat on a chair, 1.5 metres from the front of the subject's cage, and waited for one minute to elapse before commencing recording. Each subject was observed for 11 minutes. At the end of a test, the observer stood up, moved the DTU trolley and the chair to the appropriate position for the next subject, and proceeded in exactly the same manner as before. At the end of a day's testing all recording apparatus was removed from the nursery.

From the age of 5 months until the end of observations at 7 months, home cage checksheet observations were carried out from behind the observation screen (see Section 3.2.2), and in front of the screen, on alternate weeks. This alternating weekly schedule was also operated with DTU sessions from Day 25 of each subject's weekday rearing condition. This alteration was to enable the effects of observer obtrusiveness to be assessed, but this question is not considered in the present report. However, all weekend observations were made from in front of the screen, i.e., in full view of the subjects.

With the constraint that daily home cage checksheet observations were always completed before DTU testing began, the order in which the subjects were observed on any day was random. Table 2 summarizes the rearing conditions and testing schedules.

Table 2. Rearing conditions and home cage testing schedules.

Subjects	Days of Week 'Weekday'	Social Partner	Tests	Days of Week 'Weekend'	Social Partner	Tests
Mirror-Only	Mon, Tue, Wed, Thu	Mirror	Check-sheet, DTU	Fri, Sat, Sun	Alone	Check-sheet
Mirror-Perspex	"	Mirror	"	"	Peer behind Perspex	Check-sheet, DTU
Peer-Only	Mon, Tue Wed, Thu	Peer	Check-sheet, DTU	Fri, Sat, Sun	Alone	Check-sheet
Peer-Mirror	"	Peer	"	"	Mirror	Check-sheet, DTU
Alone[1]	Mon, Tue Wed, Thu	Alone	Check-sheet	Fri, Sat, Sun	Alone	Check-sheet

Footnote 1: Only one Alone subject was observed at weekends for the first 3 months

During the last two months of home cage testing, i.e., the last 5 weeks of observations on one of the Alone animals, and the last 2 months of testing the Mirror-Perspex pair, the experimenter was unavailable, due to involvement in another, unrelated project. Instead of direct observations during this period, each day videotapes were made of the home cage behaviours of these three animals. Technicians carried out the actions of the author while video recording was in progress, e.g., sitting quietly in front of, or behind, the observation screen. The technician playing the role of the experimenter also scored the occurrence of two checksheet behaviours, namely Look Observer and Vocalization. The video equipment was left in position for two hours on the two days immediately prior to the first videotaped session, so that the animals would be familiar with it. Apart from the two behaviours mentioned above, all other checksheet behaviours, and all DTU behaviours, were later scored from the videotapes by the author.

3.4 Analysis and Predictions

1. Home cage checksheet. Using the data obtained from sessions in which the observer was in front of the screen, monthly totals were calculated for checksheet behaviours. Two behaviours were then dropped from the analysis. These were Look Environment and Look Observer, which were not clearly distinguishible from each other on videotape. Furthermore, Look Environment occurred at universally high frequencies (almost 100%), and Look Observer was scored suspiciously infrequently by the technicians during the videotaped sessions. All remaining checksheet categories were included in between and within subjects analyses of variance (anovas). There were two between subjects factors. One was 'Social Partner'. For mirror-reared subjects,

the principal social partner available during rearing was the mirror image, whereas for peer-reared subjects it was a peer. The second between subjects factor, termed 'Additional Experience', concerned whether or not the animals received additional 'social' experience at weekends, i.e., during separations from their principal social partners. MX and PM subjects did receive additional experience, namely a peer behind Perspex and a mirror, respectively, while MO and PO subjects did not.

'Months' (1-5) and 'Time'(Weekday or Weekend) were within subjects variables. The number of additional within subjects variables varied according to the aim of the particular anova. Analysis of the home cage checksheet data was primarily aimed at two questions. One was whether mirror-reared infants would form attachments to their reflections similar to those which peer-reared infants were expected to form to their cagemates. A strong form of Cairns' (1966) proximity hypothesis would lead to the prediction of mirror-oriented attachments in mirror-reared animals possibly as strong as those in peer-reared animals. Alternatively, the notion that contact comfort is critical to the development of attachment in monkeys (Harlow and Zimmermann, 1959; Harlow and Soumi, 1970) leads to the expectation of the strongest attachments in peer-reared animals. The relative strengths of the attachments were assessed by comparing the degree of behavioural disruption produced in the infants by separation from their principal rearing partners, i.e., at weekends (see Harlow and Suomi, 1974; Mineka and Suomi, 1978).

The second question was whether the presence of a mirror could offset the absence of a true social companion, and retard or diminish the appearance of behaviours typically reported in isolates. If tactile/kinesthetic stimulation from social partners is important in this respect (see Mason and Berkson, 1975; Prescott, 1975), then the absence of this input in the mirror condition should result in more

evidence of an 'isolation syndrome' in mirror-reared than in peer-reared animals.

The anovas, and some specific associated predictions, are outlined below.

(i) Environment- and self-directed activity. In this analysis 'Behaviour' (Manipulate, Oral, Aggress), and 'Direction' (Environment or Self) were repeated measures. If a mirror can function as an adequate rearing companion, then the two groups should not differ markedly in their tendencies toward environment- and self-directed behaviours.

(ii) Diaper-directed activity. The three diaper-directed behaviours, namely Look, Manipulate, and Clasp, were considered in one anova. Since infant monkeys seek contact comfort, it was expected that animals denied true physical contact with peers, i.e., mirror-reared infants, would contact their diapers more than would peer-reared infants. Diaper contact could be expected to increase equally in mirror- and peer-reared groups at weekends if both groups were equally attached to their social partners. Overall attention to the diaper, especially clasping, was expected to diminish with increasing age.

(iii) Locomotion and vocalization. Walk and Climb were analyzed as repeated measures in an anova concerned with locomotion. Locomotion should increase with age, and should increase at weekends, as a facet of protest at separation from the weekday social partner (e.g., Harlow and Suomi, 1974). Vocalization was also expected to increase at weekends, for the same reason. It was analyzed singly in an anova.

(iv) Play activity. Play was also analyzed singly. It was expected to drop at weekends (Harlow and Suomi, 1974) in animals upset at being separated from an attachment figure. Play was also expected to increase with age (Suomi and Harlow, 1975). Play Environment and Play Self were scored separately in the last two months. The latter might be expected to be more evident in animals without physical access to

conspecifics (Anderson and Chamove, 1980, 1981).

(v) The 'isolation syndrome'. The four behaviours Autoeroticism, Self-Clasp, Stereotypy, and Bizarre Posture were treated as repeated measures in one analysis. Since these behaviours often indicate disturbance, they were expected to be more evident at weekends, i.e., during separation from attachment figures. Also, if a mirror is a good substitute for a true cagemate, then mirror-reared animals should not exhibit these behaviours more than peer-reared animals.

(vi) Self-looking, drinking and scratching. With regard to the three final analyses, Look Self is more common in socially deprived infants (e.g., Baysinger et al., 1972); as is Drink (Miller et al., 1971). If mirror-reared animals are socially deprived relative to peer-reared animals, then they should exhibit these two behaviours more than peer-reared infants. Scratch sometimes indicates tension, and therefore might be more frequent during separations from attachment figures. Furthermore if frequent scratching indicates chronic agitation or disturbance, it might help distinguish which group was more agitated, mirror- or peer-reared.

In all analyses alpha was set at .05. A posteriori comparisons among means were performed using the method of the Least Significant Difference (LSD), as described in Snedecor and Cochran (1967). LSD tests were considered appropriate only for significant anova effects.

2. Home cage DTU sessions. Two behaviours, namely Submission and Sex were dropped from the analysis since they were virtually never recorded, leaving five behaviours: Exploration, Play, Aggression, Affiliation, and Oral. Analyses of variance were used to analyze the DTU data, with Social Partner (Mirror or Peer) as the between subjects variable. Two within subjects factors were employed, namely Months,

and Form of behaviour (Contact or Noncontact). Data were prepared for anova as follows: Two records per animal per week contributed toward each animal's monthly mean score for each behaviour. The two records were from Monday and Tuesday sessions, unless the subject had fallen asleep or the recording equipment had failed on those days. Three parameters obtained from the POD programme analysis of the DTU tapes were analyzed after the programme had deleted the first minute of the 11-minute test. Firstly the rate of occurence of each behaviour was analyzed, i.e., the frequency of a behaviour every 5 minutes. Rates rather than absolute frequencies were analyzed because tests sometimes ran over the scheduled 11 minutes, and because a persistent problem with the DTU's clocks meant that on many of the paper tapes a portion of the test was lost, occasionally up to 20%. Clearly in such cases rate is more appropriate than recorded frequency. In the following chapters, when rates are presented, they refer to frequencies per 5 minutes. Secondly, the percentage of total time devoted to each behaviour was analyzed, followed by the third parameter, the mean bout length of a behaviour. As in the analysis of home cage checksheet data, anovas were supplemented by the method of the Least Significant Difference (LSD). As a rule a posteriori LSD tests were restricted to significant anova effects.

In some cases where there were too few data to perform anova, each animal's overall mean was computed by collapsing months together, and the groups were compared using two-tailed t-tests for independent samples. Whenever correlation coefficients were determined, the statistic used was Pearson's r. In all analyses, alpha = .05.

The attempt to set up predictions for the analysis of DTU data ran into difficulties. For example, the known importance of physical

contact in infant monkey interactions might lead to the expectation of greater amounts of Contact behaviours in the peer-reared group than in the mirror-reared group. On the other hand, the peculiar qualities of MIS, such as its imitation of the subject and its sudden appearances and disappearances, might intensify attempts by the subject to contact it, producing more Contact activity in the mirror-reared animals. Yet another possibility is that an animal would soon habituate to a constantly mimicking partner, in contast to a true peer which can initiate, terminate, and vary interaction sequences. Such considerations, in addition to the preliminary nature of the present study, cautioned against the setting up of specific predictions.

In the following Results chapters, unless stated otherwise, all of the effects mentioned are statistically significant at $p < .05$. All significant anova effects are mentioned, but to save space, F values are presented only for effects involving between subjects variables. Other reliable F values are contained in relevant appendices. Data from the two Alone-reared subjects are presented, but these data were not formally analyzed.

CHAPTER FOUR. RESULTS: HOME CAGE CHECKSHEET OBSERVATIONS

4.1 Environment- and Self-directed Activity

SUMMARY: Aggression was rarely observed, whereas manipulation and oral exploration were common. Mirror-reared and peer-reared groups did not differ in the overall amounts of environment- and self-directed activity exhibited. Surprisingly, PM animals tended toward high levels of self-directed activity, and low amounts of environmental behaviour. The switch to Weekend housing did not affect these behaviours strongly, although it was interesting that MO and Alone subjects, in particular, obtained low self-directed scores at weekends. Self-directed behaviours during Weekend separations steadily declined over months in the PO pair, in contrast to MX and PM pairs.

The prediction that infants reared without physical access to peers would engage in more self-directed activity than those with such access was not supported by analysis of the three behaviours Manipulate, Oral, and Aggress. The only significant main effect was that of Behaviour, referring to the fact that aggression occurred in less than 1% of the 15-second intervals, while Manipulate (28%) and Oral (34%) were much more common. An interesting, though nonsignificant trend emerged for Time of test ($p = .059$), indicating a slight overall increase in activity at weekends, i.e., when the animals were separated from their principal 'social' partners.

The only reliable effect involving a between subjects variable was a Social Partner X Additional Experience X Months X Direction X Time interaction, $F(4, 16) = 4.2$, $p < .025$. This effect is illustrated in Figure 4, with the three behaviours averaged. Panels a and b, which concern environmentally directed behaviour during Weekday and Weekend

(i.e., separation) conditions, respectively, indicate that PM animals tended to exhibit relatively little mouthing, manipulation, and aggression. Interestingly, differences among the pairs only appeared after the first month (LSD = 6.9). However, the differences are on the whole not marked.

There was greater divergence among the pairs in self-directed activity (Figure 4c and d), particularly in the last two months of observation. The high self-activity scores of PM animals contrast with their low incidence of environment-directed behaviour. It is noteworthy that MO pair exhibited less Weekday self-directed activity than PM pair in every month except the first (LSD = 6.9).

During separations from the Weekday social partner, i.e., at weekends, MO pair engaged in relatively little self-directed behaviour, and this activity declined over months in PO animals, contrasting with the persistently high scores of PM pair.

Month 1 and Month 5 scores were compared in each pair, to ascertain whether behaviours changed markedly with increasing age. MO pair's Weekday environment-directed behaviour increased between Months 1 and 5, but there were no other age-related changes in this pair. MX animals showed an increase in self-directed activity during mirror-housing between Months 1 and 5, but no other changes. PO pair exhibited less self-activity in Month 5 than in Month 1, and PM animals exhibited similar amounts of self- and environment-directed behaviour in Months 1 and 5.

Figure 4 also shows the means for the two Alone subjects. Clearly, their incidence of self-directed behaviour was not dissimilar to that of the other pairs, although in the last 3 months of Weekday housing, and always at weekends, it was rather less common that in some of the other pairs. Environmentally directed behaviour was similar to that

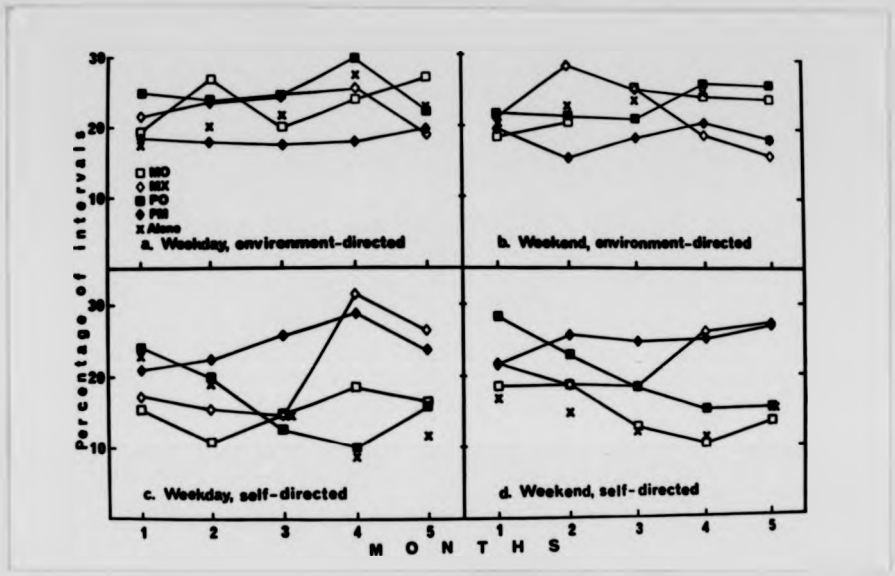


Figure 4. Environment- and self-directed activity over five months. Scores are averaged over the behaviours Manipulate, Oral, and Aggress.

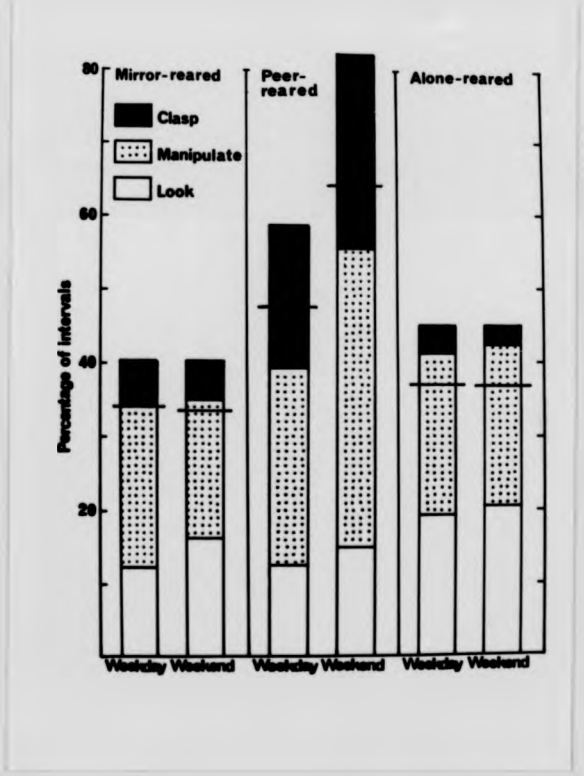
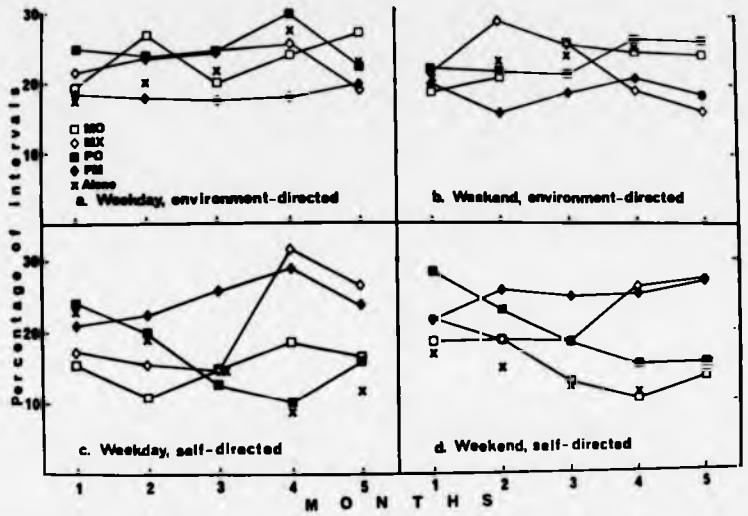


Figure 5. Diaper-directed activity during weekday and weekend conditions. The horizontal line across each bar indicates the total percentage of intervals during which at least one diaper-directed behaviour occurred, i.e. it corrects for overlap in behaviours within one 15-sec interval.



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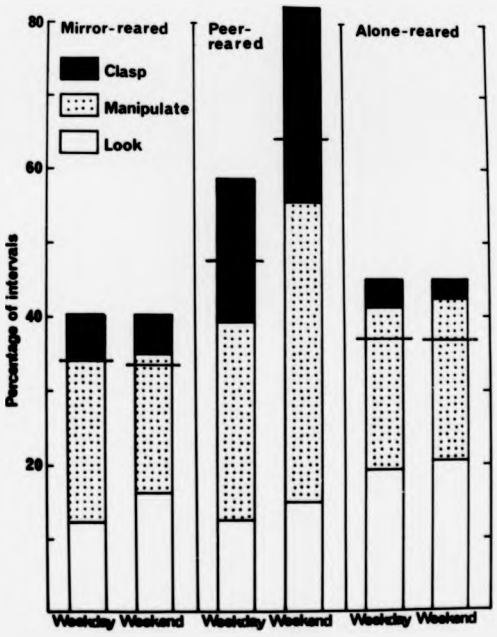

Figure 5. Diaper-directed activity during weekday and weekend conditions. The horizontal line across each bar indicates the total percentage of intervals during which at least one diaper-directed behaviour occurred, i.e. it corrects for overlap in behaviours within one 15-sec interval.

of the pairs reared with a 'social' partner. Perhaps the most interesting comparisons involving the Alone pair are with MO pair, since the latter rearing condition was identical to that experienced by the Alone subjets, except for the presence of a mirror during weekdays. It is interesting, therefore, that at weekends, when mirror-separation occurred for MO animals, but when Alone subjects were simply placed into another home cage, these two pairs of subjects never differed in either environment- or self-directed activity. In contrast, the other three pairs of animals all engaged in more self-directed behaviour than these pairs at various Weekend periods. There were no noticeable Weekday-Weekend differences in the Alone animals' behaviour in any month.[1] Self-directed activity dropped between Months 1 and 5 in Weekday sessions.

4.2 Diaper-directed Activity

SUMMARY: The prediction that animals reared without physical contact with a peer would engage in more diaper-directed activity was contradicted. Although animals reared entirely alone looked at the diaper more than did mirror-reared or peer-reared infants, the peer-reared group always clasped their diapers more than did the other animals. Furthermore, Diaper contact behaviours increased during separations in peer-reared, but not in mirror-reared animals, supporting the hypothesis that peer-attachments were stronger than mirror-attachments. The provision of a substitute social partner, i.e., a peer behind Perspex for MX infants, or a mirror for PM infants, did not appear to reduce the separation reaction.

Footnote: For Months 1-3, Weekend Alone scores are based on one subject (see Section 3.3.1).

Contrary to expectation, peer-reared animals engaged in 75% more diaper-directed activity than the mirror-reared group, $F(1, 4) = 8.4$, $p < .05$. Social Partner interacted with Behaviour (Look, Manipulate, Clasp), $F(2, 8) = 4.4$, $p = .050$, and together these variables interacted with Time (Weekday or Weekend), $F(2, 8) = 6.4$, $p < .025$. The composite Social Partner X Behaviour X Time interaction is illustrated in Figure 5 (LSD = 6.1). It can be seen that in the mirror-reared group (MO and MX pairs), manipulation was the most common Weekday Diaper behaviour, occurring in 22% of intervals, followed by looking (12%), then the relatively infrequent clasping (6%). At weekends, during mirror separations, both Look Diaper and Manipulate Diaper remained 3-4 times more common than Clasp Diaper. Manipulation was also the most frequently recorded Weekday diaper-directed behaviour in the peer-reared group (PO and PM pairs), occurring in 27% of intervals. In these animals, however, clasping the diaper (19%) was more common than looking at it (13%), and this decreasing order of Manipulate, Clasp, and Look endured at weekends. The overall greater occurrence of Manipulate was also indicated by the Behaviour main effect. Look Diaper and Clasp Diaper both occurred in around 14% of intervals, just more than half the score for Manipulate (27%).

Interestingly, while the change to Weekend housing did not significantly affect any diaper-directed activity in the mirror-reared group, true peer-separated animals exhibited reliable increases in Diaper contact, i.e., in the categories Manipulate and Clasp. This finding supports the hypothesis that peer-reared monkeys were more attached to their cagemates than were mirror-reared animals to their reflections, causing the former group to be more agitated at separation.

Comparing each behaviour between the two groups, looking at the diaper did not differ between them, while Manipulate and Clasp did.

The former category was more characteristic of peer-reared animals at weekends, while clasping the diaper was more common both at weekends (over 5 times) and during Weekday housing (over 3 times). These differences are reflected in the Social Partner X Behaviour interaction (see above), which LSD tests indicated was largely due to (a) the high (34%) Manipulate score of the peer-reared group relative to its scores for the other categories (Look: 14%; Clasp: 23%), and (b) the difference between the two groups' scores on Clasp (18%) and Manipulate (14%).

The means for the two Alone subjects are also plotted in Figure 5. These animals were expected to exhibit relatively high amounts of diaper-directed behaviour, but as can be seen from the figure, this materialized only for Look Diaper. Their diaper-directed activity did not change at weekends. It is particularly noteworthy that diaper clasping in the two Alone animals was always infrequent, as in mirror-reared subjects, remaining 4-5 times less than in peer-reared infants.

The only other significant effect from the anova on diaper-directed activity data was a Months X Behaviour interaction. The most notable features of this interaction were that Manipulate was more common than Clasp in Month 1, and more common than both Clasp and Look in all subsequent months. The latter two behaviours did not vary in frequency over months, whereas Manipulate showed clear peaks in Months 3 and 5.

4.3 Locomotion and Vocalization

SUMMARY: The main findings were that only one of the forms of locomotion increased at weekends in each group of subjects: Peer-reared animals walked more during separations, whereas mirror-reared animals climbed more, but walked less. Vocalization, which is considered to be a reliable indicator of agitation, increased during

separations only in the peer-reared group. Alone-reared subjects were relatively non-vocal.

Locomotion was a frequent behaviour, Walk occurring in 45% of intervals and Climb in 51%. A reliable effect of Months was attributable to locomotion being more frequent in all months subsequent to the first one. The small, but reliable increase in locomotion at weekends upheld the prediction of increased locomotion during separations from attachment figures. Walk rose from 44% to 45% of intervals, Climb from 50% to 53%. There were two interactions involving the Social Partner variable: Social Partner X Behaviour X Time, $F(1, 4) = 38.7$, $p < .005$, and Social Partner X Months X Behaviour X Time, $F(4, 16) = 7.7$, $p < .0025$. Since the main interests here concern overall differences between groups, and Weekday-Weekend differences, month-to-month fluctuations will be ignored. Two sets of comparisons were made. Firstly, within-group scores were tested for Weekday-Weekend effects, and then inter-behavioural comparisons were made, to determine the relative dominance of the behaviours. The effect is illustrated in Figure 6; LSD = 4.51

At weekends, i.e., during separations from the principal social partners, mirror-reared animals exhibited more climbing and less walking than during weekdays; and peer-reared animals increased walking. Climbing was always the more common behaviour in both groups.

The two Alone subjects' means are also included in Figure 6. They walked rather less than mirror-reared infants, and climbed less than peer-reared infants during weekdays. Walking did not change at weekends, but climbing increased dramatically. Inspection of the raw data revealed that this increase was almost entirely due to two large increases by the single Alone subject observed at Weekends in the first three months.

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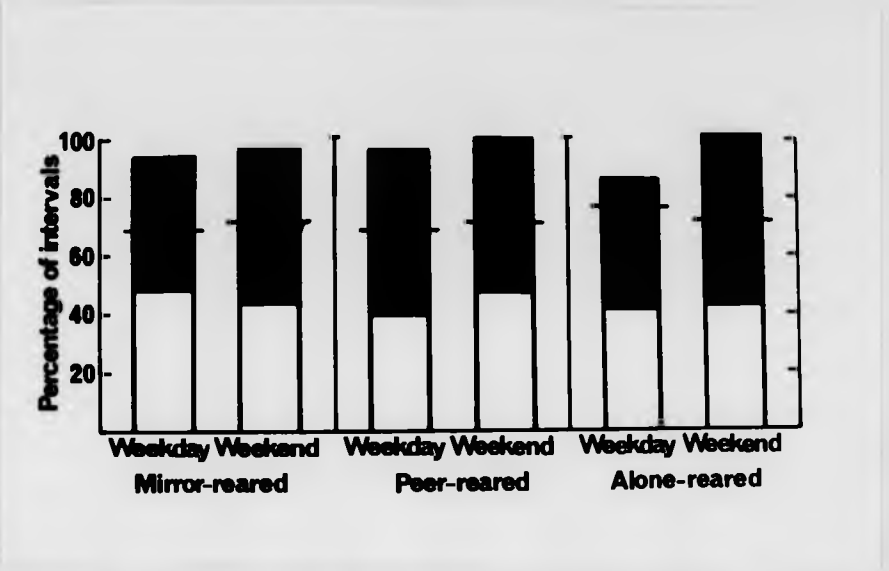


Figure 6. Locomotion during weekday and weekend housing conditions. Light bars: Walk; dark bars: Climb.

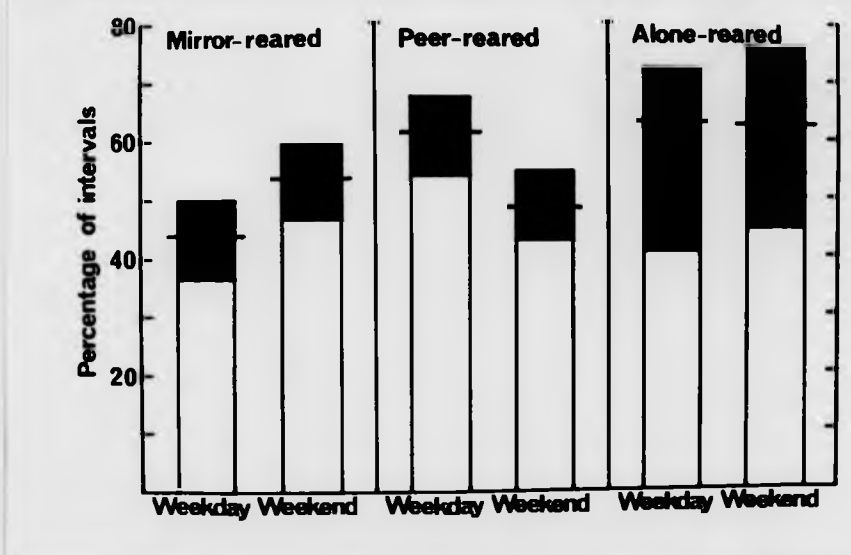
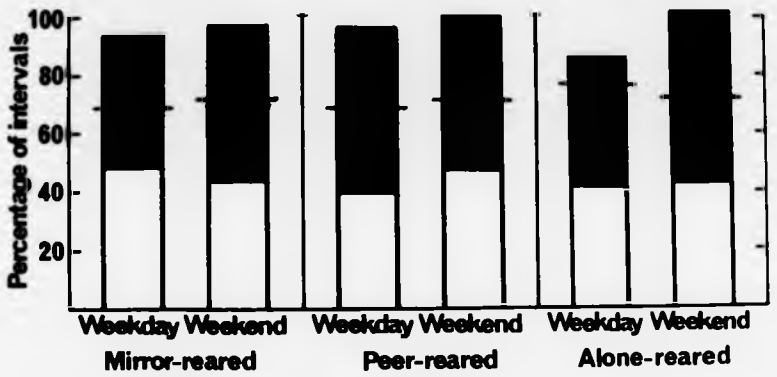


Figure 7. Play activity during weekday and weekend conditions. Light bars: Play environment; dark bars: Play self.



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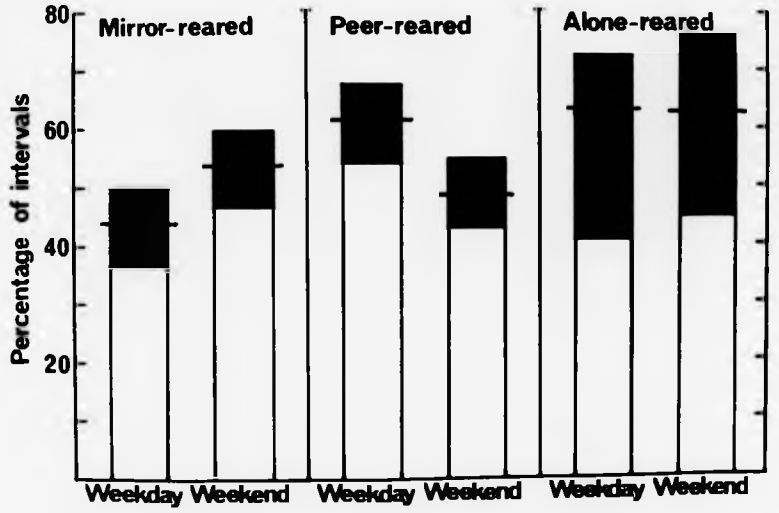


Figure 7. Play activity during weekday and weekend conditions. Light bars: Play environment; dark bars: Play self.

Vocalization peaked at around 40% of intervals in Months 2 and 3, and averaged between 27% and 30% in other months. A significant main effect of Time was obtained, which indicated increased vocalization rates at weekends. However, Time interacted with Social Partner, $F(1, 4) = 25.1$, $p < .01$. LSD comparisons revealed that whereas the mirror-reared group's vocalization score did not vary between Weekday sessions (27%) and Weekend sessions (30%), vocalization in the peer-reared group more than doubled, from 23% to 52%. This marked difference between mirror- and peer-reared animals supports the contention that the latter group were more attached to the social partner, and were consequently more agitated by separation.

The Weekday vocalization average of the two Alone animals was 8%, and the Weekend score 14%, both considerably lower than the respective mirror-reared and peer-reared scores.

4.4 Play Activity

SUMMARY: As expected, Play increased after the first month, but did not clearly distinguish among the rearing conditions or between Weekday and Weekend conditions until Months 4 and 5. Peer-reared animals, but not mirror-reared or Alone-reared, showed decreased environment-directed play in response to separations. The MX pair unexpectedly increased Play Environment at weekends. Self-directed play was three times more common in Alone subjects than in mirror- or peer-reared infants.

In the first three months, Play rose steeply from around 30% of intervals in Month 1, to over 50% of intervals in Months 2 and 3. The other significant effect was Social Partner X Additional Experience X Months, $F(2, 8) = 5.3$, $p < .05$. The MO pair was more playful than

all other pairs in Month 1. Play increased in all pairs in Month 2, but the rise in PM pair was relatively smaller, giving them the lowest score in this month. A large increase by the PM pair in Month 3, however, eliminated the differences. The two Alone subjects obtained Weekday scores of 18% in Month 1, 42% in Month 2, and 53% in Month 3, similar to the other pairs. Play in the first three months was not affected by social separation at weekends.

In the last two months of observation, there was no overall differentiation among rearing conditions. Environment-directed play was over 3.5 times more common than self-directed play. Time (Weekday or Weekend) was involved in two interactions: with Social Partner, $F(1, 4) = 47.5$, $p < .005$, and with Social Partner and Direction (Environment or Self), $F(1, 4) = 10.3$, $p < .05$. Comparisons among means in this latter effect revealed that the peer-reared group performed more Play Environment than did the mirror-reared group, but only during weekdays. A drop in this play activity by peer-reared infants, coupled with an increase by the mirror-reared group, eliminated the difference at weekends (Figure 7, LSD = 5.5). Inspection of the data revealed that the unanticipated increase in Play Environment at weekends in mirror-reared animals was principally due to the MX pair. Play Self was not affected by Weekend housing, remaining at between 11% and 14% in both mirror- and peer-reared groups.

The picture as regards play in the two Alone subjects provides an interesting contrast with the two main groups (Figure 7). In Alone animals neither type of play was affected by the Weekday-Weekend switch. Levels of Play Environment were similar to those recorded for mirror-reared animals, but Play Self (PS) was approximately three times as common as in mirror-reared or peer-reared animals.

4.5 The 'Isolation Syndrome'

SUMMARY: Autoeroticism, Self-clasp, Stereotypy, and Bizarre Posture were not very commonly observed. Social separations did not influence the frequencies of these isolation syndrome behaviours. Although mirror-reared animals tended to show more abnormal behaviour in the early months, peer-reared animals eventually caught up with them. The two Alone animals obtained only slightly more extreme scores than mirror-reared animals.

Month 5 had the greatest incidence of the four isolation syndrome behaviours, while Month 3 had the lowest. Autoeroticism and Bizarre Posture occurred more frequently than Stereotypy. They were both also over twice as common as Self-clasp, but this difference did not exceed the LSD. Isolation syndrome behaviours occurred equally frequently in the Weekday and Weekend conditions. The monthly mean occurrence of individual behaviours never reached 10% of intervals in mirror- or peer-reared animals. The highest score for the Alone subjects was 20%, referring to autoeroticism in Month 1. The generally low incidence of the isolation syndrome is evident in Figure 8, which illustrates the Social Partner X Months interaction, averaging over the four behaviours $F(4, 16) = 4.2$, $p < .025$. Two main factors account for the interaction. Firstly, mirror-reared animals obtained a low isolation syndrome score in Month 3. More importantly, a gradual increase in abnormal behaviours by the peer-reared group, resulting in a higher score in Month 5 than in any of the first three months, acted to eventually diminish the difference between the two groups (LSD = 1.3). Additional Experience X Months, $F(4, 16) = 4.5$, $p < .025$, indicated that the additionally experienced pairs (MX and PM) showed increased

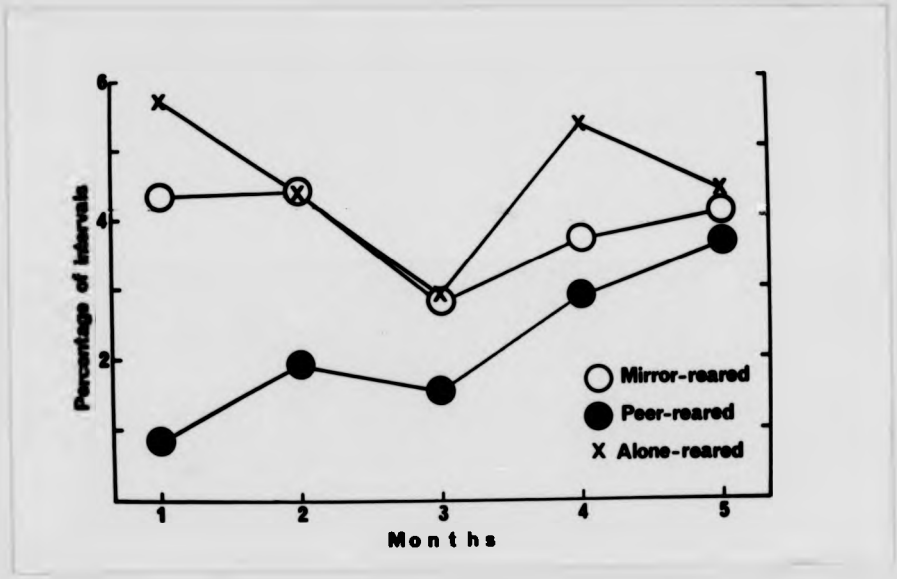


Figure 8. Isolation syndrome activity over five months. Scores are averaged over the behaviours Autoeroticism, Self-clasp, Stereotypy, and Bizarre posture.

majority of descriptions are based on deductions from anatomical studies.

The film also shows details of the life cycle of *L. cerealium* and symptoms of the damage they cause to

levels of those behaviours in the last two months, whereas MO and PO pairs did not.

Figure 8 also shows that the two subjects reared entirely alone tended to resemble mirror-reared animals more than peer-reared, but exhibited slightly more abnormal behaviours in two of the months.

Additional Experience X Behaviour, $F(3, 12) = 3.5$, $p < .06$, and Social Partner X Additional Experience X Behaviour, $F(3, 12) = 5.1$, $p < .025$, showed that MO pair's main isolation syndrome behaviour was Autoeroticism, MX pair's was Bizarre Posture, PO pair exhibited equally low levels of all the behaviours, while PM pair engaged in equal amounts of Autoeroticism and Bizarre Posture.

4.6 Self-looking, Drinking, and Scratching

SUMMARY: Look Self did not reliably distinguish mirror- and peer-reared animals. Alone subjects engaged in most self-looking. Mirror-reared animals drank more at weekends, while scratching almost doubled in PM animals at weekends.

Although the mirror-reared group performed Look Self almost twice as much as the peer-reared group, this behaviour yielded no significant anova effects. It may be noted, however, that Alone animals engaged in over three times as much self-looking as did peer-reared animals.

The category Drink showed a Social Partner X Time interaction, $F(1, 4) = 10.5$, $p < .05$. Mirror-reared animals increased their amount of drinking at weekends, to a level above that of the unvarying peer-reared group. This mirror-reared Weekend increase was unanticipated. A Months X Time effect indicated monthly variation in the Weekday-Weekend differences, but this was not analyzed further.

There was a highest order interaction of Social Partner X Additional Experience X Months X Time in the Scratch analysis, $F(4, 16) = 3.5$, $p < .05$. Also significant were Social Partner X Time, $F(1, 4) = 12.7$, $p < .025$, and Social Partner X Additional Experience X Time, $F(1, 4) = 9.3$, $p < .05$. Only this last effect was examined. Visual inspection of the data was sufficient to detect the event responsible for the effect. In the PM pair scratching rose sharply from 6% to over 11% at weekends. This increase also produced the Social Partner X Time interaction mentioned above. The Weekend increase in scratching by PM animals might reflect increased tension in the mirror condition.

4.7 Overview of Home Cage Checksheet Results

During separation from their cagemates at weekends, peer-reared monkeys increased manipulation and clasping of the cotton diaper, walking, and vocalization, while environmentally directed play decreased. This overall pattern suggests that the peer-reared animals were disturbed by the peer-separation experiences. In mirror-reared animals, on the other hand, diaper contact was not affected by mirror-separations, nor was vocalization rate, although one form of locomotion, namely climbing, did increase. In general, these results support the prediction that animals reared with physical access to a peer would form stronger emotional attachments to the cagemates than would mirror-reared infants to their reflections.

In the first two months of the study, the mirror-reared group exhibited a stronger tendency toward 'isolation syndrome' activities than did the peer-reared group, suggesting that a mirror was inferior to a cagemate in preventing the appearance of abnormal behaviours. However, increases in isolation syndrome behaviours in the Peer-Mirror pair eliminated the difference in the last three months, rendering the

the above conclusion untenable. Possible reasons for the increasing performance of these behaviours by the peer-reared group will be considered in the Discussion (Chapter 9). It was evident, however, that although some abnormal behaviours were present, signs of an isolation syndrome were not prominent in any of the animals, and that manipulation, orality, and aggression measures were not sensitive measures of the treatment effects.

The two Alone-reared subjects provided useful data against which to compare the behaviours of subjects in the main experimental groups. The relatively high scores of the Alone animals on some behaviours, such as Look Self, Play Self, the isolation syndrome; their low incidence of vocalization; and the general absence of Weekday-Weekend differences (e.g., environment-, self-, and diaper-directed activities, vocalization, play), strengthens the evidence for behavioural effects resulting from the experimental rearing conditions. It is interesting that there was generally more resemblance between Alone subjects and mirror-reared animals than between Alone and peer-reared animals. There were also trends, however, which suggested that the presence of a mirror could reduce the severity of the consequences of being reared entirely alone.

Few effects of the Additional Experience variable emerged above the major treatments of mirror- or peer-rearing. One notable trend was for Peer-Mirror animals to score fairly low on environment-directed manipulation, orality, and aggression, and fairly high on the self-directed equivalents. If high levels of self-directed activity can be taken to indicate a certain amount of disturbance then PM animals would appear to tend toward greater disturbance than other pairs. The PM pair was also the only one to show increased scratching at weekends, which could signify agitation during mirror housing. An informal

analysis of the patterns of diaper contact further revealed that PM pair's Weekday Clasp Diaper score was also considerably higher than that of any other pair. As mentioned in Section 4.4, it was also discovered that the Weekend increase in Play Environment by the mirror-reared group was due to MX pair in particular, suggesting a difference in the response to mirror-separation in the mirror-reared pairs.

Subtle within mirror- and peer-rearing effects such as those mentioned above suggest that more detailed behavioural analyses might detect further differences. For example it would be of interest to discover whether the increased environment-directed play at Weekends in the MX pair reflected large amounts of play being directed toward the peer behind Perspex, or whether the greater Weekday Play Environment scores by peer-reared animals was attributable to a true cagemate eliciting more social play than a mirror. Direct measurement and comparison of social behaviours toward the rearing partners was the primary function of the home cage DTU sessions. The following chapter presents some of the results.

CHAPTER FIVE. RESULTS: HOME CAGE DTU OBSERVATIONS. 1. WEEKDAY SESSIONS

5.1 Monthly Means

1. Exploration. SUMMARY: Peer-reared animals explored their cagemates more frequently than mirror-reared animals explored their own reflections. In both groups the rate and percentage of time measures of Noncontact Exploration were higher than that of Contact Exploration. The proportion of time devoted to social exploration was greatest in Month 1; individual exploratory bouts being longest in this month.

Peer-reared infants engaged in a higher rate of social exploration than did mirror-reared infants (means: 20.9 and 15.0 times per 5 minutes, respectively), $F(1, 6) = 9.0$, $p < .025$. Figure 9 shows the monthly means for Contact and Noncontact forms separately. Over both groups, the mean rate of Noncontact Exploration (14.6) was over 4 times that of Contact Exploration (3.4). The noncontact form of social exploration also took up a greater percentage of test time than exploration involving contact, 8.6% and 2.6% respectively. Months was a reliable effect in the percentage analysis, indicating that the animals explored their social partners more in Month 1, at an average of 14.5% of time, than in all subsequent months (LSD = 3.4). The two groups did not differ in the overall amount of time spent in social exploration, nor in the mean duration of exploratory episodes.

The mean duration of social exploratory bouts paralleled the age-related pattern obtained in the percentage analysis, i.e., mean bout length of exploration in Month 1 (2.8 seconds) was longer than in all subsequent months (1.5-2.0 seconds).

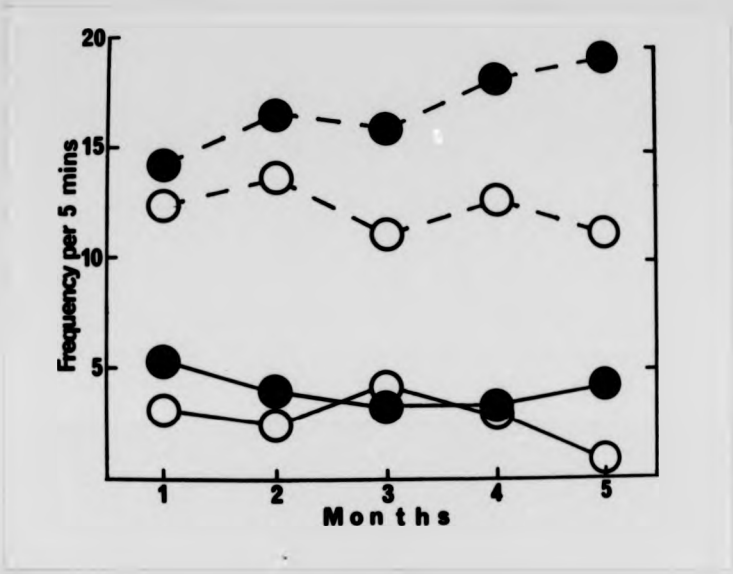


Figure 9. Rate of social exploration over five months.
○:mirror-reared;●:peer-reared;—:contact;- -:noncontact.

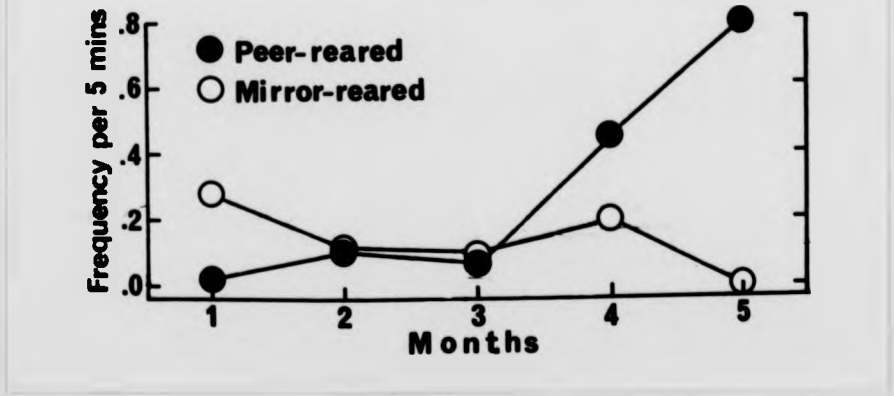
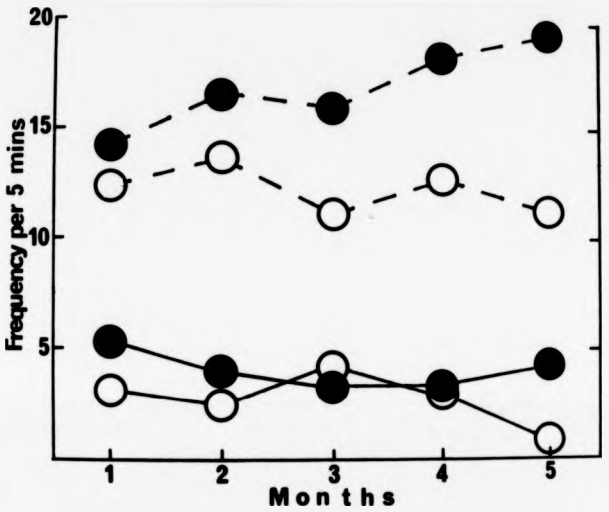


Figure 10. Rate of social aggression over five months.



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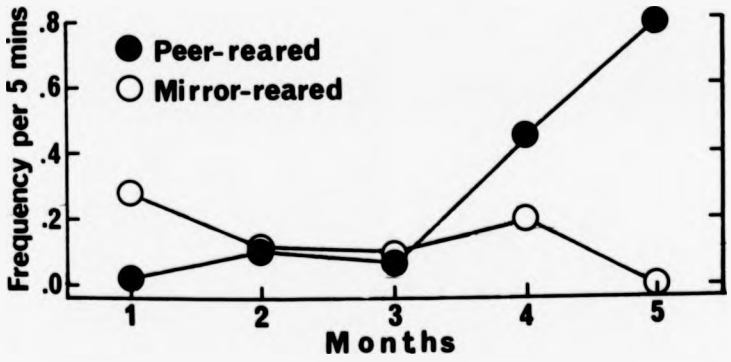

Figure 10. Rate of social aggression over five months.

2. Orality. Oral contact with the social partner was a very rare event, the mean rate never exceeding 0.3 occurrences per 5 minutes. The percentage of total time involved in the Oral category never exceeded 0.3% in any month. Rate and percentage measures were subjected to anova, and no significant effects were found. Bout length was analyzed using a t-test, but there was no difference between the groups. This behaviour was dropped from all further analyses.

3. Aggression. SUMMARY: Whereas aggression remained at a very low rate in mirror-reared animals, peer-reared animals exhibited increased levels of aggression in Months 4 and 5.

Social aggression occurred rarely, but it differentiated the two groups. One reliable effect emerged from the analysis of rate of aggression, namely a Social Partner X Months interaction, $F(4, 24) = 4.3$, $p < .01$. This effect is illustrated in Figure 10. The rate of social aggression in mirror-reared animals did not vary across months, whereas aggression rate in the peer-reared group rose toward the end of testing. By Month 5 peer-directed aggression was occurring more frequently than in any of the first three months. In contrast, no mirror-directed aggression was observed in Month 5. There were no significant effects in the analysis of the amount of time in aggression.

A t-test on the mean length of bouts of aggression revealed no difference between the groups.

4. Play. SUMMARY: Social partner-directed play occured more frequently, and accounted for a higher proportion of time in peer-reared than in mirror-reared animals. Contact Play, in particular, was more evident in the peer-reared group, this form taking up a larger

percentage of time than either type of play in the mirror-reared group. Individual bouts of Contact Play were longer in peer-reared animals.

Social play differed in the two main rearing groups in several ways. Peer-reared animals engaged in social play approximately twice as frequently as did mirror-reared animals, $F(1, 6) = 18.2$, $p < .0075$ (rates of 14.7 and 7.3 respectively). They also spent twice as much time in social play as the mirror-reared group (11.3% versus 5.5%), $F(1, 6) = 8.2$, $p < .05$. Interestingly, this latter effect interacted with Form, $F(1, 6) = 11.5$, $p < .025$, as can be seen in Figure 11. Mirror-reared animals engaged in Contact Play with their reflections 2.1% of the time, and in Noncontact Play 3.4%. The corresponding values in peer-reared animals were 6.7% and 4.6%. While the difference between the two forms of play was not reliable in the mirror-reared group, it was in the peer-reared group (LSD = 1.8). Furthermore, the amount of time spent in social play involving physical contact by peer-housed infants was greater than the amount of time devoted to either type of play in the mirror reared group. Even Noncontact Play in peer-reared animals was more common than Contact Play in mirror-reared animals.

Overall, Noncontact Play was the more frequent form, but age differentially affected the frequency of engaging in both types of play, as indicated by the Months X Form interaction. Contact Play occurred most frequently in Month 3 (6.0), and declined in frequency thereafter. In contrast, Noncontact Play steadily increased from the Month 1 rate of 4.5 times per 5 minutes, to 7.5 in Month 5.

Form also interacted with Months when social play was considered in terms of the amount of time it accounted for. Contact Play was

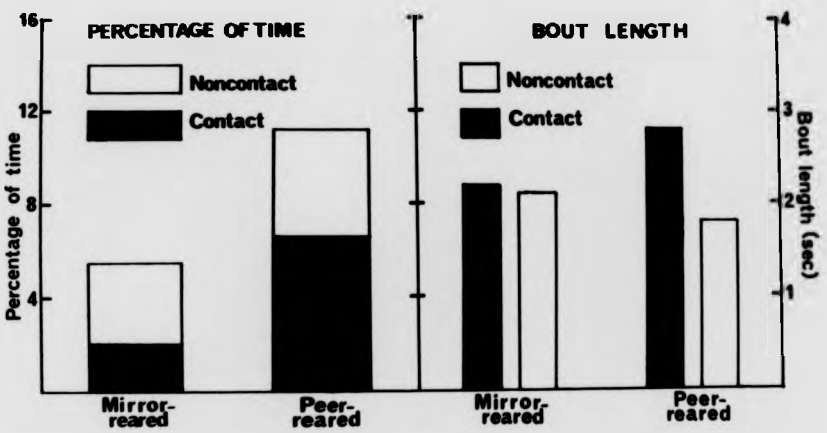

Figure 11. Amount of social play, and play bout lengths.

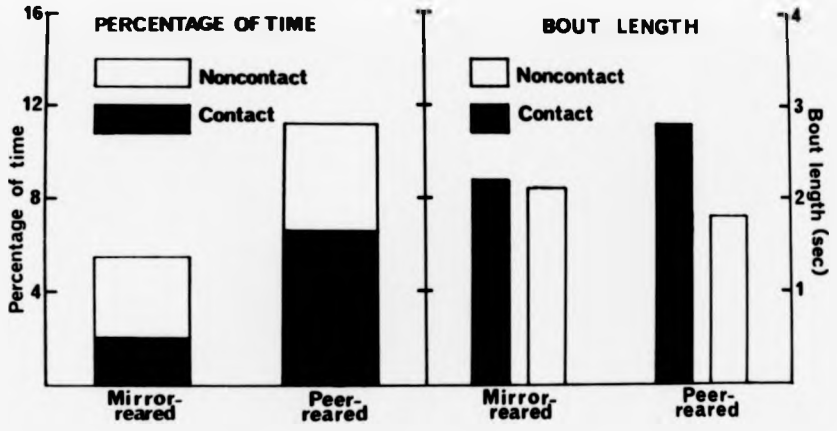

Figure 11. Amount of social play, and play bout lengths.

most common in Month 1 (5.8%), and least common in Months 4 and 5 (2.9% and 3.2%). The only significant monthly variations in time spent in Noncontact Play were the greater scores in Months 2 and 3 compared to Month 1.

Month of testing also had a strong effect on the mean length of individual bouts of play, such that play episodes were rather shorter in months 4 and 5 than in the first three months. Play bouts involving physical contact with the partner (peer or mirror surface) lasted an average of 2.5 seconds, slightly but reliably longer than Noncontact Play bouts, which averaged 2.0 seconds. However, bout length of the two forms of play depended upon the type of social partner available to the subjects $F(1, 6) = 7.4$, $p < .05$. Whereas in the mirror-reared group bout length was almost indistinguishible whether the play involved contact (2.2 seconds) or not (2.1 seconds), Contact Play bouts in the peer-reared group were longer than bouts of both forms in the mirror-reared group (2.8 seconds), and the peer-reared group's own Noncontact Play bouts (1.8 seconds, LSD = 0.6, see Figure 11).

5. Affiliation. SUMMARY: Mirror- and peer-reared animals did not perform different amounts of affiliative behaviour toward their social partners. Contact Affiliation was more common than Noncontact Affiliation.

Rather surprisingly, the two groups did not differ reliably in the amount of affiliative behaviour shown toward their respective social partners. Contact Affiliation in Month 1 was twice as frequent in the peer-reared group as in the mirror-reared group, but neither this nor any other group difference was significant. In both rate and percentage analyses, only Form produced a reliable effect, referring to

the greater occurrence of affiliation involving physical contact with the partner, than affiliation exhibited through facial expressions. Peer-directed Contact Affiliation accounted for 3.1% of time, and mirror-directed 2.1%

6. Total responsiveness. SUMMARY: During rearing, more behaviour was directed toward the real cagemate than toward the mirror image. Comparison of the two rearing groups by combining the four behaviours Exploration, Aggression, Play, and Affiliation, showed that social responses occurred at a higher rate in the peer-reared group (37.0 per 5 minutes) than in the mirror-reared group (23.4), $F(1, 6) = 32.3$, $p < .0025$. The former group also spent a larger percentage of total time in social behaviour than did animals with mirrors as social companions (27.0% and 17.8% respectively), $F(1, 6) = 10.1$, $p < .01$. Mirror-contact steadily decreased from 10.1% in Month 1 to 1.5% in Month 5. Peer-contact was initially twice as common (21.1%), and even though it had declined by half by Month 5, at 9.2% it was still markedly more prominent than the mirror equivalent. These monthly means are taken from the nonsignificant Social Partner X Months X Form effect. The mean bout length of the 'average' behaviour did not differ between the groups.

5.2 Variability in Behaviour

It has been shown that responding for mirror-image reinforcement in Siamese fighting fish is more variable than responding for a more traditional reinforcer such as food (Bols and Hogan, 1979; Hogan, 1967). There appear to be no published reports of direct comparisons of variability in behaviour when MIS and true conspecifics are the stimuli.

The behaviour of the two groups of monkeys in the present study was analyzed for differences in variability. On the one hand it might be expected that the greater independence and diversity of activity in a true peer would be associated with high variability in the behaviour of the partner. Alternatively, it might be the case that precisely the lack of behavioural initiative and diversity in a reflection could product unstable, i.e., variable responsiveness toward that 'partner'.

The above two possibilities were examined by comparing standard deviations (SDs) in the two groups. Two procedures were carried out. Firstly, day-to-day variability within months was investigated, i.e., the variability around the means on which the previous analyses were based (Section 5.1). Secondly, variability around monthly mean bout lengths was estimated. Only the behaviour categories Exploration and Play provided sufficient amounts of data for meaningful comparisons to be made. A full table of means and significant effects is available in Appendix 4, but only effects involving the Social Partner variable are presented in the text below.

1. Within-month variability. SUMMARY: Performance of social exploration was not significantly more variable from day to day in one group or the other. However, daily variability in social play was more marked in the peer-reared group than in the mirror-reared group, with Contact Play revealing the most extreme differences.

With regard to social exploration, standard deviations never differed significantly between mirror- and peer-reared groups in rate, percentage of time, or bout length. In contrast, variability in social play was clearly not equal in the two groups. Firstly, the overall SD regarding

rate of Play in the peer-reared group (3.7) was reliably greater than that in the mirror-reared group (2.3), $F(1, 6) = 13.0$, $p < .025$. The Social Partner X Form interaction, $F(1, 6) = 18.4$, $p < .0075$, revealed that the main effect was largely attributable to the very low SD for Contact Play in the mirror-reared group, although the SD for Noncontact Play was also low, compared to the peer-reared group's values (Figure 12).

The percentage of total time spent in social play also varied more from day to day in the peer-reared group, $F(1, 6) = 6.7$, $p < .05$. Again, the Social Partner X Form interaction was conspicuous, $F(1, 6) = 11.8$, $p < .025$. Contact Play in peer-reared animals was more variable from day to day than in mirror-reared animals (SDs = 3.7 and 2.0 respectively). Indeed the peer-reared Contact Play SD was larger than that for any other play event (LSD = 1.7, Figure 12). There was no difference between the groups in daily variability of individual play bout lengths.

2. Within-day variability. The previous section was concerned with variation in behaviour from day to day. This section describes an an analysis of moment-to-moment variability in the duration of play and exploration episodes. Bout length samples were obtained by selecting the daily record from each month which contained the subject's highest rate of the behaviour. Bout lengths of each occurrence of the behaviour were calculated from the raw DTU printout, and a mean and SD calculated using a maximum of 30 instances of the event in any one record. The data were then run in an anova.

SUMMARY: Instances of social exploration were not more variable within a given day in either group, but length of Contact Play bouts was highly variable from moment to moment in peer-housed animals.

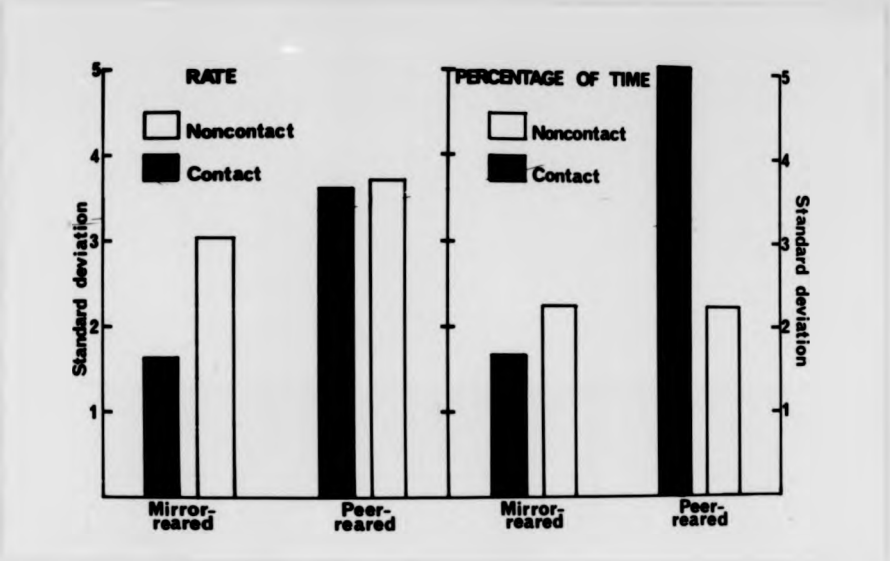

Figure 12. Standard deviations associated with monthly means for social play measures.

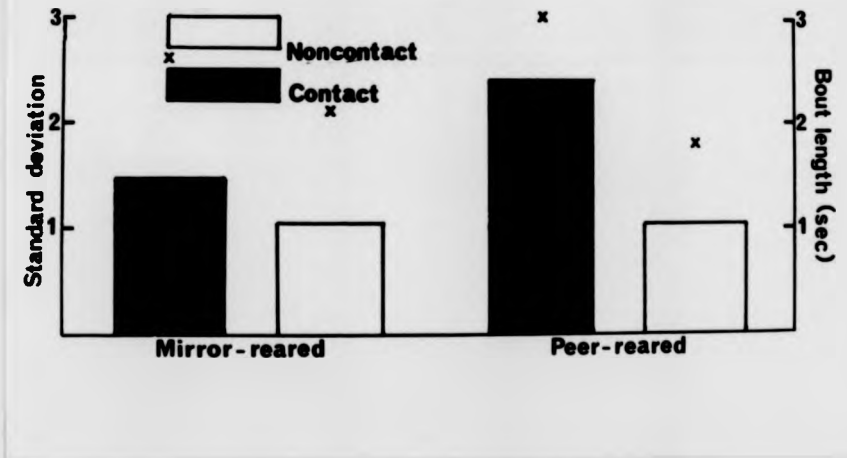

Figure 13. Standard deviations associated with social play bout lengths. x denotes the corresponding bout length.

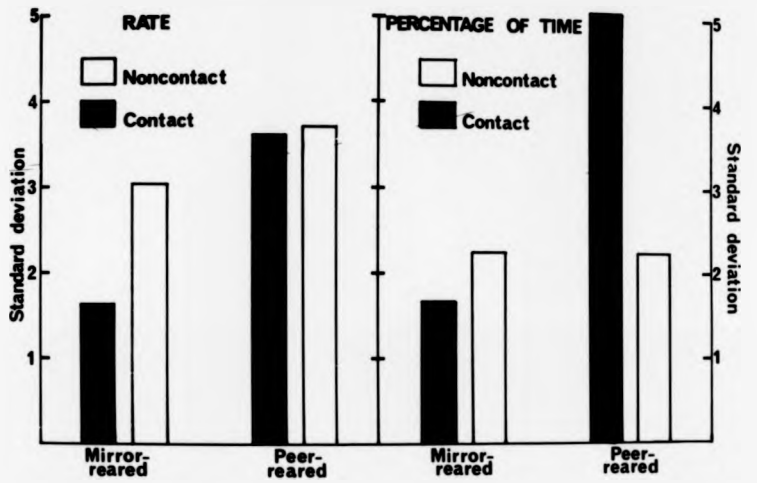

Figure 12. Standard deviations associated with monthly means for social play measures.

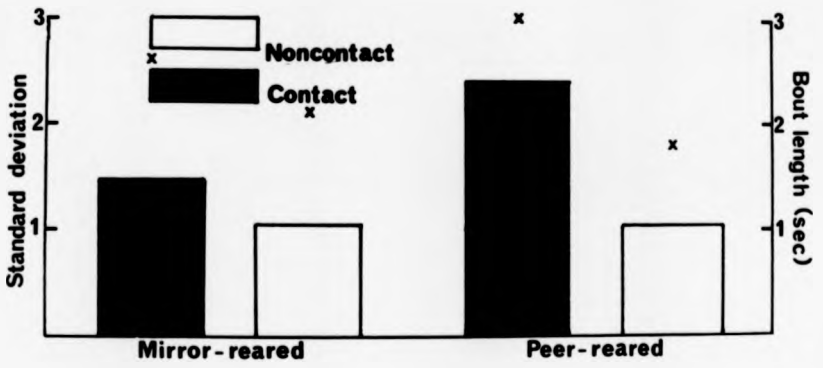

Figure 13. Standard deviations associated with social play bout lengths. x denotes the corresponding bout length.

Standard deviations around daily mean social exploration bout lengths did not differ between the groups. In contrast, Social Partner X Form in the analysis of Play data was reliable, $F(1, 6) = 10.5$, $p < .025$. Contact Play episodes in peer-reared animals were more varied in duration on a given day (SD = 2.4) than were any other social play events in either group (LSD = .10, Figure 13).

5.3 Analysis of Correlations

SUMMARY: Indices of Exploration and Play tended to be positively correlated, whereas correlations between other behaviours were not reliably in one direction. Mirror- and peer-reared groups did not differ in the extent to which their social behaviours were correlated. Several correlations between different parameters within a behaviour were significant, but they did not differentiate the two rearing groups.

Two analyses were performed on correlations calculated from the DTU records. The first analysis asked whether the two rearing groups differed in the degree of correlation among their social behaviours. To answer this, correlation coefficients among the four behaviours were calculated for all subjects. Rate, percentage of time, and bout length measures, as well as the two forms of each behaviour were treated separately. Resulting full sets of data were analyzed by anova; incomplete sets by independent t-tests. There were no significant differences between mirror-reared and peer-reared animals in the extent to which social behaviours were inter-correlated. Group correlations are presented in Table 3. Applying sign tests to the thirteen sets of data clarified that the direction of the correlations was significant only between behaviours Exploration and Play, combining over both groups and forms of behaviours.

Table 3. Group correlation coefficients between behaviours.[1]

Behaviours	Form	Parameter					
		Rate		Percentage of time		Bout length	
	Groups:	MR	PR	MR	PR	MR	PR
Exploration - Aggression	Contact	.08	.02	.35	-.25		
	Noncontact	-.01	.49	-.16	.21		
Exploration - Play	Contact	.78	.52	.72	.25+	.46	.48+
	Noncontact	.62	.82*	.62	.27+	.62	.13+
Exploration - Affiliation	Contact	.36	-.16	.32	.28		
	Noncontact	.00	.24	.04	-.03		
Aggression - Play	Contact	-.01	-.06	-.01	-.09		
	Noncontact	-.27	.30	-.26	.38		
Aggression - Affiliation	Contact	.00	-.20	-.23	-.15		
	Noncontact	.27	.46	.34	.55		
Play - Affiliation	Contact	.07	-.31	.25	-.06		
	Noncontact	-.07	.34	.56	.35		

Footnotes:

1. The mirror-reared group's Aggression and Affiliation data are based on three animals.

* Indicates that the sign of the correlations is significant over the total 16 cases, $p < .005$.

\+ Indicates that the sign of the correlations is significant over the total 16 cases, $p < .025$.

Table 4. Results of sign tests on correlations among parameters.[1]

Parameters		Behaviour	Combinations of correlations				
			Both groups, both forms	Contact	Non-contact	Mirror-reared	Peer-reared
Rate -	Percentage of time	Exploration	.001 +	.01 +	.01 +	.01 +	.01 +
		Play	.001 +	ns	.01 +	ns	.01 +
Rate -	Bout length	Exploration	ns	ns	ns	ns	ns
		Play	ns	ns	ns	ns	ns
Percentage of time	Bout length	Exploration	.005 +	.01 +	ns	ns	ns
		Play	ns	ns	ns	ns	ns

Footnote: 1. The most common direction of the correlations is indicated beside the significance level.

Table 5. Interparameter group correlation coefficients.

Parameters	Behaviour	Form	Group	
			Mirror-reared	Peer-reared
Rate - Percentage of time	Exploration	Contact	.82	.78
		Noncontact	.93 *	.67
	Play	Contact	.90 *	.79
		Noncontact	.57	.91 *
Rate - Bout length	Exploration	Contact	.37	.47
		Noncontact	-.25	-.52
	Play	Contact	.38	.00
		Noncontact	-.39	-.17
Percentage of time - Bout length	Exploration	Contact	.79	.89 *
		Noncontact	.32	.22
	Play	Contact	.62	.38
		Noncontact	.25	-.02

* $p < .05$

The second analysis based on correlations concerned the relationships among the different parameters of a single behaviour. For example, rate of occurence of a behaviour usually correlates well with total time devoted to that behaviour (e.g., coefficients of .70 to .99, Chamove, 1974a). This analysis asked whether the size of correlations among the three parameters would differentiate the two groups, thus suggesting possible differences between a mirror image and a true peer in their response-eliciting properties. Such an analysis of MIS does not appear to have been done before.

Inter-parameter correlations could only be calculated for the two most common social behaviours, namely Exploration and Play. There were no significant differences between the groups in the sizes of correlations among measures of a given behaviour. As shown in Table 4, the direction of the correlations was significant in several instances; rate and percentage measures were strongly biased toward being positive. This directionality effect was significant for each behaviour when (a) both groups and forms were combined, (b) all Noncontact correlations were considered, (c) the peer-reared group's correlations were considered alone.

Turning to the absolute values of the correlations (Table 5), the mirror-reared group exhibited significant positive correlations between rate and percentage of time measures in Noncontact Exploration and Contact Play. For the peer-reared group, significant positive values were obtained in Contact Exploration and Noncontact Play.

5.4 Overview of Weekday DTU Home Cage Results

Table 6 presents a summary of the differences between mirror-reared and peer-reared animals in how they responded to their respective social companions.

Table 6. Summary of significant Social Partner effects in social behaviour.

Behaviour	Parameter	Result	Prob.	Comments
Exploration	Rate	Mirror < Peer	.025	Only the main effect reliable
Oral		No differences		
Aggression	Rate	Month 5: Mirror < Peer	.01	Only interaction with Months reliable
Play	Rate	Mirror < Peer	.0075	Only the main effect reliable
Play	Percentage of time	Contact: Mirror < Peer Noncontact: Mirror = Peer	.025	The main effect also reliable: p < .05, Mirror < Peer
Play	Bout length	Contact: Mirror < Peer Noncontact Mirror = Peer	.05	Only the interaction with Form reliable
Affiliation		No differences		
Total	Rate	Mirror < Peer	.0025	Only the main effect reliable
	Percentage of time	Mirror < Peer	.025	Only the main effect reliable

Mirror-reared animals were observed to respond socially to the mirrors in their home cages. They explored the reflection visually and manually, huddled against it, played with it, sometimes directed facial expressions toward it, and were occasionally aggressive toward it. Some social orientation persisted in their behaviour throughout the five months of home cage testing. In several respects the mirror image impressively resembled a true peer. For example in both groups of subjects, bouts of social exploration were longest in the first month, the month in which social exploration was at its highest. The Month 3 peak in the rate of Contact Play, the later decline in this behaviour, and the increase from Month 1 in Noncontact Play were all general effects, i.e., not differing between the groups. The overall uniformity in the patterns of correlations between and within behaviours further indicates that the mirror shared some social properties with the real peer.

In several aspects of social behaviour, however, there were clear differences between mirror-reared and peer-reared animals, affirming the greater potency of a true cagemate in eliciting and/or maintaining social interaction. Peer-reared infants exhibited over 50% more social behaviour than did mirror-reared animals. For example social exploration was more frequent in animals housed with a peer. This difference could mean several things. It could reflect stronger social attachments in peer-reared animals, as suggested by the home cage checksheet results discussed in Chapter 4; it could reflect the greater attention-eliciting properties of a dynamic, complex live stimulus, compared to an entirely contingent mirror image; and/or it could reflect 'social monitoring' directed at a potentially aggressive social partner. The latter interpretation receives some support from the finding that aggression increased in peer-reared animals, but not mirror-reared,

toward the end of testing.

If the opportunity for complex, physical contact-based interaction is an important feature distinguishing the two rearing conditions, then the absence of group differences in Contact Exploration and Contact Affiliation is somewhat surprising. One form of behaviour involving gross physical contact, namely Contact Play, did clearly differentiate the two groups, being three times more common in the peer-reared group. Individual bouts of Contact Play were longer in peer-housed animals. These results suggest that contact-based play activity, rather than more traditional affectional behaviours, e.g., huddling, affiliative facial expressions, was a useful measure of attachment in the rearing conditions in this study. The latter behaviours were not exhibited differentially toward a real peer and a mirror. Finally, it was found that social play was expressed more variably in peer-reared animals, in terms of day-to-day engagement in play, and length of bouts of Contact Play. This underlines the greater flexibility of interactions involving a true, physically accessible conspecific, compared to a mirror image.

The following chapter is concerned with differences in behaviour between the two pairs of animals in each rearing group; differences in responsiveness to a mirror between animals reared primarily with a mirror and those also reared with a real cagemate; and differences in behaviour toward a fully accessible peer and a peer behind a transparent partition.

CHAPTER SIX. RESULTS: HOME CAGE DTU OBSERVATIONS. 2. WEEKDAY-WEEKEND COMPARISONS

6.1 Aims

This chapter presents the results of three sets of analyses aimed at four major questions. Firstly, behaviours of the PM animals toward their mirrors were compared with those of the mirror-reared animals (MO and MX), the main question being whether animals with full experience of a live peer differed in their mirror reactions from animals whose entire conspecific experience had been in the form of MIS. It might be expected that the relatively limited social potential of the mirror image would result in rapid habituation in peer-experienced monkeys. On the other hand, the peculiarities of MIS compared to a true peer might enhance investigation and/or playfulness in PM monkeys. No specific predictions were made.

Secondly, behaviour toward a fully accessible cagemate (PO and PM pairs) was compared with behaviour toward a peer housed on the other side of a transparent partition (MX animals). Of course this comparison focuses on the role of physical contact in peer-interaction. The Perspex condition in the present study resembles 'partial isolation' housing, the consequences of which are well documented in rhesus monkeys. However, the author is aware of no systematic investigations of the behaviours exhibited by animals toward neighbouring monkeys in partial isolation rearing.

A third issue, which was also accommodated in the above analyses, concerned the extent to which the two pairs of animals within each rearing group differed in home cage social behaviour. For example, by analyzing the variation between MO and MX animals, the effects of the additional experience available to the latter pair (i.e., the peer

behind Perspex at weekends) could be assessed. Behaviours of PO and PM pairs were likewise analyzed.

Two sets of anovas were run with respect to the three issues outlined above. As far as possible the repeated measures were identical to those employed in the analyses of home cage behaviour as described in Chapter 5. In both sets of anovas 'Pair' was the between subjects variable, i.e., three pairs in the analysis of mirror-directed behaviour (MO, MX, PM), and three in the analysis of peer-directed behaviour (PO, PM, MX).

The third block of analysis concentrated on those pairs of subjects who experienced two types of social partner during rearing, namely MX and PM pairs. Their behaviours were analyzed in anovas with Time (Weekday or Weekend) as a repeated measure. These within-subjects comparisons constitute a direct method of comparing different types of social stimuli, by examining the same subjects in different situations.

6.2 Comparisons among Pairs in Mirror-directed Activity

A summary of differences among MO, MX, and PM pairs in mirror-directed behaviour is available in Table 7. The results are described in some detail below.

1. Exploration. SUMMARY: There were no overall differences among the three pairs of monkeys in exploration of their mirrors. While Non-contact Exploration initially occurred most frequently in the MX pair, by the end of home cage testing it had declined to a rate lower than that of the MO pair, whose rate increased in every month. PM animals were intermediate in rate of looking at the reflection. There were no differences among the pairs in total exploration time. Bouts of exploration were longer in MO animals than in other pairs in the first

month, and overall length of social exploration bouts tended to decrease gradually across months.

In all three pairs of monkeys, Noncontact Exploration of the mirror was 3 to 4 times more frequent than Contact Exploration. Pair X Months X Form was significant, $F(8, 12) = 3.4$, $p < .05$. Contact Exploration, always the less frequent form, never varied significantly among months or pairs (although the rate in Month 5 was 2-6 times less than in Month 1). However, Noncontact Exploration did reveal differences. Initially, this behaviour was less frequent in MO pair than in MX and PM animals (Figure 14a). The behaviour never varied much across months in PM animals, but steadily increased in frequency in MO animals, from a rate of 6.6 per 5 minutes in Month 1 to 14.5 in Month 5 (LSD = 4.9). In sharp contrast, in Months 3-5 rate of Noncontact Exploration in MX pair was approximately half of the rate in the first two months.

As might be expected from earlier results, Noncontact Exploration accounted for nearly 4 times as much time as the Contact form (means: 7.6% and 2.2% respectively). There were never reliable differences across the pairs in total time devoted to mirror exploration.

The mean lengths of bouts of social exploration varied over months, being longer in Month 1 than in any other. This effect, and the Pair X Months interaction can be seen in Figure 14b, $F(8, 12) = 3.3$, $p < .05$. Social exploration episodes were significantly longer in MO pair than in MX and PM pairs in the first month (LSD = 0.9). After that there were no pair differences.

2. Aggression and affiliation. SUMMARY: No differences emerged among the pairs with respect to aggression. Affiliation involving physical contact with the mirror surface was more common than Noncontact

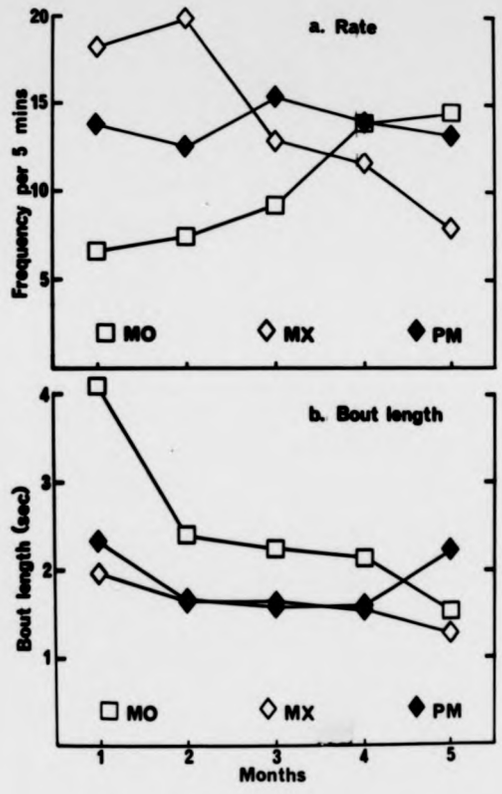

Figure 14.
Rate and bout length of mirror exploration episodes over five months.

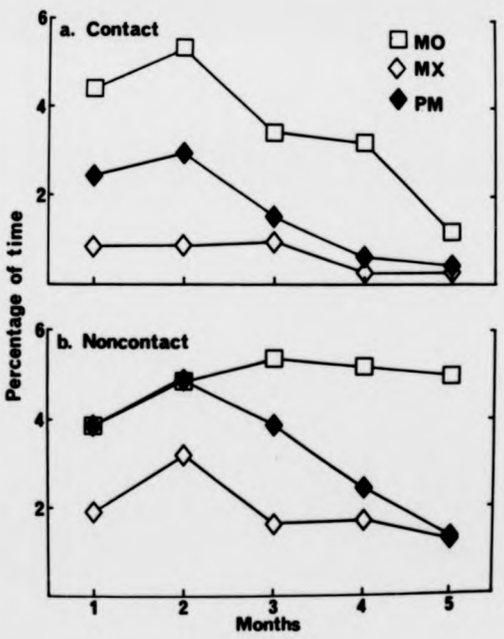

Figure 15.
Amount of time in mirror-directed play.

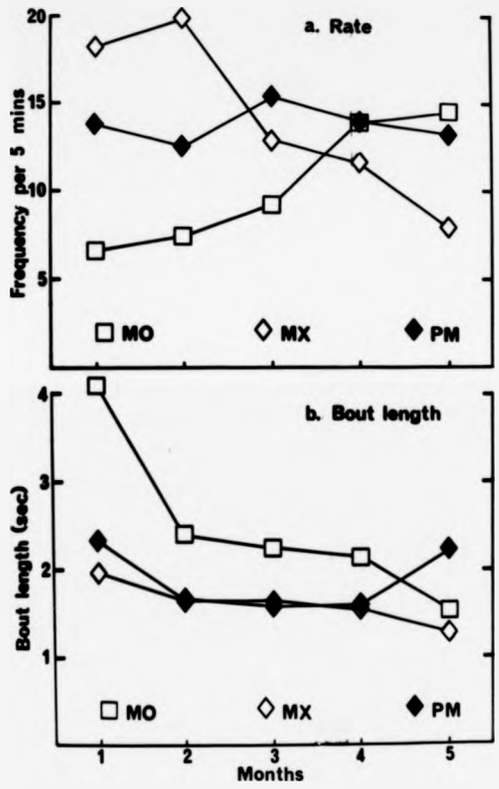

Figure 14.
Rate and bout length of mirror exploration episodes over five months.

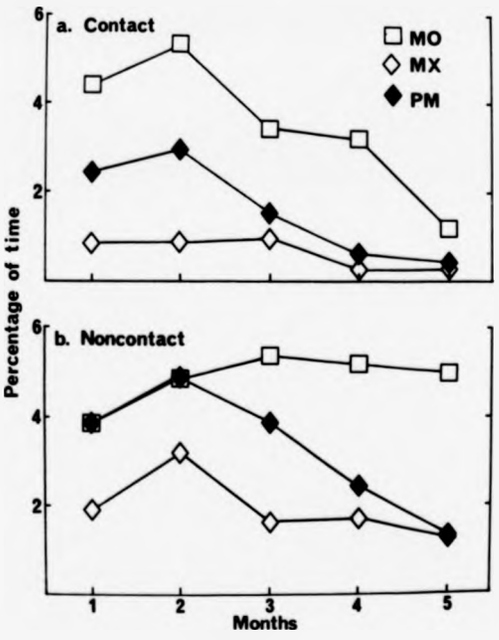

Figure 15.
Amount of time in mirror-directed play.

Affiliation. Bouts of Contact Affiliation lasted longer in the two pairs reared primarily with MIS than in PM animals.

Neither of the two measures of aggression that were analyzed, namely rate and percentage of time, yielded any reliable effects. A noteable, though nonsignificant Months trend ($p = .055$) suggested a peak in aggression rate in Month 4. Although the interaction with pair was not significant ($p = .086$), inspection of the data suggested that this peak was largely attributable to an increase in aggression in PM pair.

Main effects of Form in analysis of both rate and percentage of time indicated that Contact Affiliation with the mirror image was more common than Noncontact Affiliation. Bout length of affiliative episodes could only be analyzed for Contact Affiliation. There was a marked difference among the pairs in the mean length of Contact Affiliation bouts. On average such bouts lasted over 4 seconds in MO and MX pairs, but they lasted less than 1 second in PM animals, $F(2, 3) = 9.1$, $p < .025$.

3. Play. SUMMARY: The three pairs of subjects did not differ in frequency of mirror-directed play, but MO animals engaged in greater total amounts of Contact Play than did MX animals, except for a decrease in the last month. PM animals were initially intermediate in Contact Play, but later dropped to levels like those of MX pair. Similar trends were apparent for Noncontact Play, although MO and PM pairs started off at similar levels, and it did not decrease in MO pair in Month 5. In general, play tended to decrease toward the end of testing. Individual play bouts were longest in MO pair, at least for the first three months.

Noncontact Play was more frequent in all three pairs than was play involving contact with the mirror. Inspection of the means from the

nonsignificant Pair X Months X Form effect ($p = .067$) suggested an overall lower rate of both types of play in MX pair compared to MO pair. PM pair started off like MO animals, but dropped in later months. In contrast, rate of Noncontact Play tended to rise steadily in MO pair. As reported below, these trends reached significance in the percentage of time analysis.

MO animals exhibited more play than PM animals, who exhibited more than MX pair (8.4%, 4.9%, and 2.6% of time, respectively), $F(2, 3) = 48.8$, $p < .005$, LSD = 1.8. All three pairs exhibited more Noncontact Play than Contact Play. Figure 15 illustrates the Pair X Months X Form interaction, $F(8, 12) = 3.7$, $p < .025$. Looking firstly at Contact Play, (a), it is clear that MO animals played more than MX pair in every month except the last, where a decrease in the former pair's score diminished the difference (LSD = 1.5). Mirror-directed Contact Play in PM pair lay between that of the other two pairs initially, but then dropped to a low level similar to that of MX animals. Overall, Contact Play tended to decrease over months, e.g., from a mean of 2.6% of time in Month 1 to 0.7% in Month 5.

Turning to Noncontact Play (Figure 15b), MO animals exhibited more of this type of play than did MX pair. PM animals resembled MO pair for the first three months, but the behaviour then decreased to a level more like that of MX pair. As with Contact Play, Noncontact Play tended to decrease after the second month. The overall Months effect fell short of significance at $p = .068$.

Social play bout lengths further differentiated the pairs. The highest order interaction is shown in Figure 16, $F(8, 12) = 3.3$, $p < .05$. Contact Play episodes lasted longer in MO animals than in MX or PM animals in every month except the last. The latter pairs never differed

from each other, nor did either of their bout lengths vary across months (LSD = 0.6). In contrast, bout length in MO animals underwent two reliable decreases, in Months 3 and 5. Noncontact Play patterns provide a very similar picture. The Pair main effect demonstrated clearly that play episodes were longest in MO animals (2.9 seconds), compared to 1.7 seconds for PM pair and 1.4 seconds for MX pair (LSD = 1.0), $F(2, 3) = 13.4$, $p < .05$. Highly significant were the Months effect, and the Pair X Months interaction, $F(8, 12) = 5.3$, $p < .0075$. Play bout length steadily declined in MO pair, culminating in a value not reliably different from that of the other pairs. In MO animals bout length dropped from 3.7 seconds to 1.7 seconds. Neither of the other pairs exhibited much bout length variability over months, values remaining between 1.2 and 1.7 seconds (MX) and 1.5 and 1.9 seconds (PM). LSD for Pair X Months was 0.5.

4. Total responsiveness. SUMMARY: MO animals were the most responsive to the mirrors. MX and PM animals did not differ from each other. Although mirror-directed behaviours tended to decrease in length over months, in Month 5 bout length almost tripled in PM monkeys.

Overall responsiveness was measured by combining the data for Exploration, Aggression, Play and Affiliation. Only effects involving the Pair variable are presented here. There were no overall differences among the pairs in rate of social responding. The Pair X Months X Form interaction just fell short of significance ($p = .053$). Inspection of the data indicated that contact-based mirror behaviour dropped in MX and PM animals in the last two months, and in MO pair in the final month. In MX and PM pairs Noncontact behaviours tended to decline in frequency, whereas in MO pairs it increased from an initially low level. There

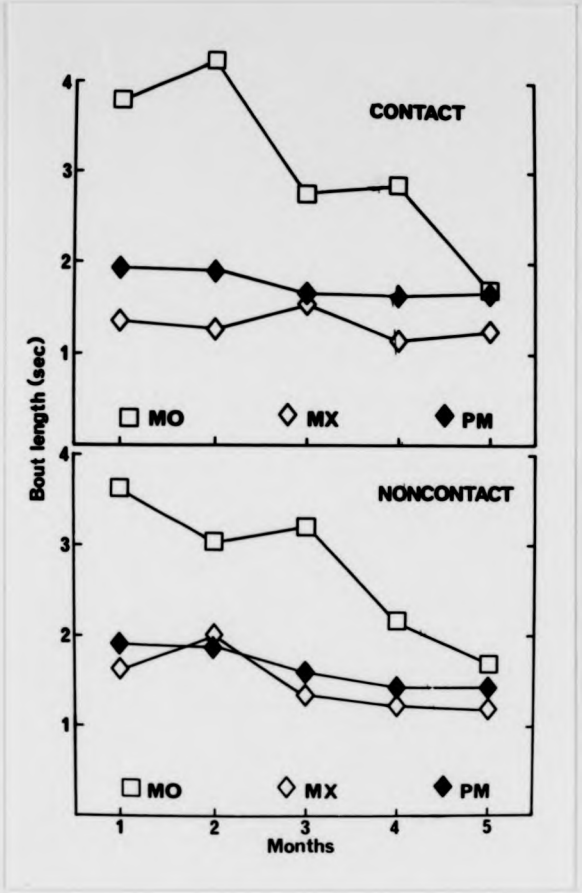

Figure 16.
Length of mirror-directed play bouts.

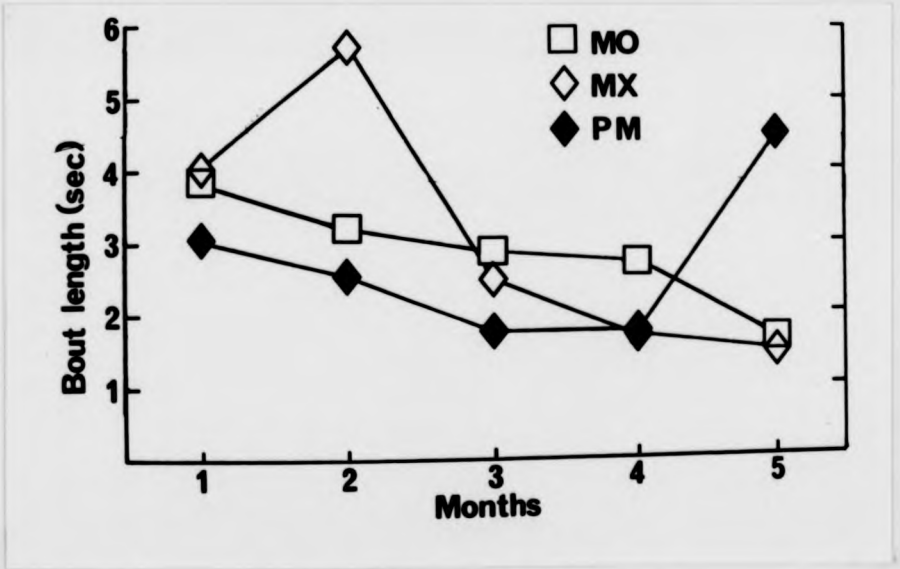

Figure 17. Length of mirror-directed activities.

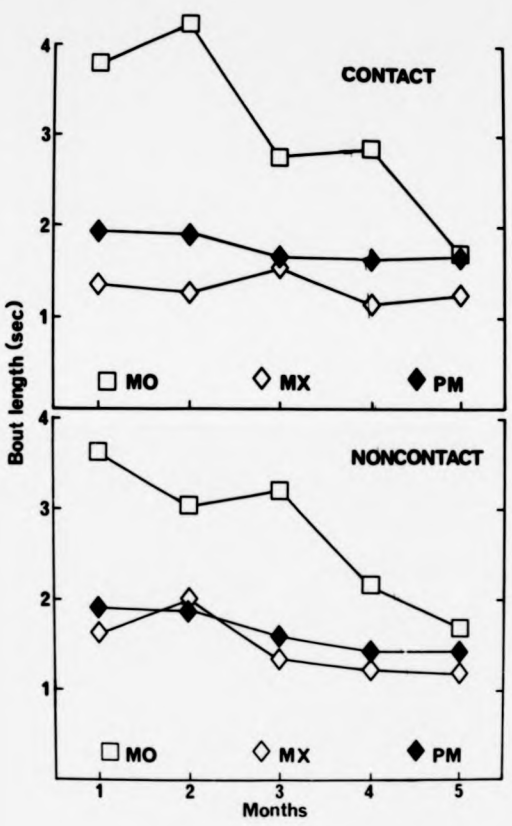

Figure 16.
Length of mirror-directed play bouts.

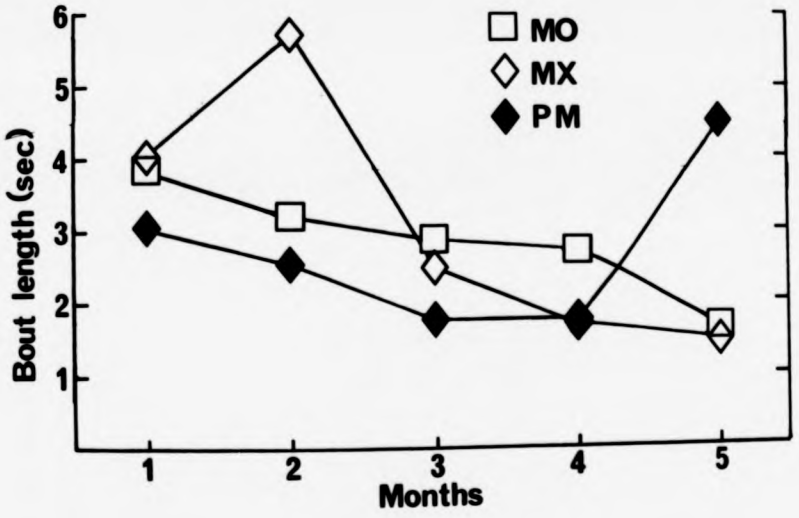

Figure 17. Length of mirror-directed activities.

Table 7. Summary of Significant Pair effects in mirror-directed activity.

Behaviour	Parameter	Result	Prob.	Comments
Exploration	Rate	Month 1: MO<MX+PM Month 2: MO<MX>PM, MO<PM Month 3: MO<PM Month 4: No differences Month 5: MO>MX	.05	Only the Pair X Months X Form interaction reliable. No differences in Contact Exploration. Results refer to Noncontact form
Exploration	Bout length	Month 1: MO>MX+PM Month 2: No differences Month 3: No differences Month 4: No differences Month 5: No differences	.05	Only the interaction with Months reliable
Aggression		No differences		
Play	Percentage of time	Contact Month 1: MO>MX<PM (MO>PM) Month 2: MO>MX<PM (MO>PM) Month 3: MO>MX+PM Month 4: MO>MX+PM Month 5: No differences Noncontact: Month 1: MO>MX<PM Month 2: MO>MX<PM Month 3: MO>MX<PM Month 4: MO>MX+PM Month 5: MO>MX+PM	.05	The main effect also reliable: MO>MX<PM (MO>PM), $p < .005$. Results are from the interaction with Months and Form

Table 7 contd.

Behaviour	Parameter	Result	Prob.	Comments
Play	Bout length	Contact:		
		Month 1: MO>MX+PM	.05	The main effect also reliable: MO>MX+PM, $p < .05$. Also reliable was the interaction with Months, $p < .0075$.
		Month 2: MO>MX+PM		
		Month 3: MO>MX+PM		
		Month 4: MO>MX+PM		
		Month 5: No differences		
		Noncontact:		
		Month 1: MO>MX+PM	.05	Results are from the interaction with Months and Form
		Month 2: MO>MX+PM		
		Month 3: MO>MX+PM		
		Month 4: MO>MX+PM		
		Month 5: No differences		
Affiliation	Bout length	MO + MX > PM	.025	Only this effect obtained
Total	Percentage of time	MO > MX + PM	.025	
Total	Bout length	Month 1: No differences	.05	Only the interaction with Months reliable
		Month 2: MX > PM		
		Month 3: No differences		
		Month 4: No differences		
		Month 5: MO+MX<PM		

was a reliable Pair effect in the percentage of time spent in social activity with the mirror image. This value was greater in MO pair (20.2%), than in MX and PM pairs (15.4% and 16.8%), the difference between the latter two pairs not exceeding the LSD of 2.2, $F(2, 3) = 25.5$, $p < .025$.

Finally, whereas bout length of the 'average' mirror-directed behaviour generally decreased across months in the two mirror-reared pairs, this trend in PM animals was interrupted by a large increase in bout lenth in Month 5, $F(8, 12) = 2.9$, $p < .05$ (Figure 17).

6.3 Comparisons among Pairs in Peer-directed Activity

A summary of differences among PO, PM, and MX pairs in peer-directed behaviour is given in Table 8. The results are presented in some detail below.

1. Exploration. SUMMARY: Social Exploration was very similar in the the two peer-reared pairs of monkeys. Exploration of the peer behind Perspex in MX pair differed from cagemate exploration in PO and PM pairs only in that Contact Exploration bout lengths increased in MX animals over months, while they decreased in peer-reared animals. This resulted in a reversal of the original situation of longer bouts in PO and PM pairs compared to MX. Noncontact Exploration was more common than Contact Exploration, but individual bouts of the latter behaviour lasted longer.

The two peer-reared pairs of monkeys did not differ from each other either in rate, or amount of time spent in peer-oriented exploration. Nor did the MX pair differ from either of the two peer-reared pairs in these parameters. In both analyses, only Form produced a reliable

effect, Noncontact Exploration being 3-8 times more frequent than the Contact form, and over 3 times more time consuming (8.8% versus 2.5%).

Months and Form both yielded significant main effects in the analysis of length of social exploration bouts. Together these variables interacted with Pair, $F(8, 12) = 5.7$, $p < .005$. Bouts of Noncontact Exploration never differed much among the three pairs, and only two noteable changes across months were detected; in MX animals in Month 3, and PM animals in Month 4. Mean Contact Exploration bout lengths are illustrated in Figure 18. These were very similar in PO and PM pairs. From mean durations of 2.7 and 3.1 seconds respectively in Month 1, bout lengths shortened in these two pairs, so that in the last three months the mean durations were less than 2 seconds (LSD = 0.6). In contrast, while MX Contact Exploration bouts averaged a short 1.7 seconds in Month 1, their duration increased in successive months, so that in the last two months bouts lasted nearly 3 seconds, longer than in the peer-reared pairs.

2. Aggression and affiliation. SUMMARY: Aggression was rare, averaging around .1% of time. It tended to be more common in peer-housed monkeys than in Perspex separated monkeys, particularly in later months. Affiliative behaviour did not differentiate the three pairs of monkeys.

A nonsignificant Pairs trend ($p = .056$) suggested more frequent aggression in the two peer-reared pairs than in MX pair, although rates were low, not exceeding 0.4 per 5 minutes. The Months effect showed that rate of aggression increased steadily in every month. In the two peer-reared pairs aggression appeared to increase in Months 4 and 5, whereas a (smaller) peak in MX pair occurred in Month 3. However, this interaction

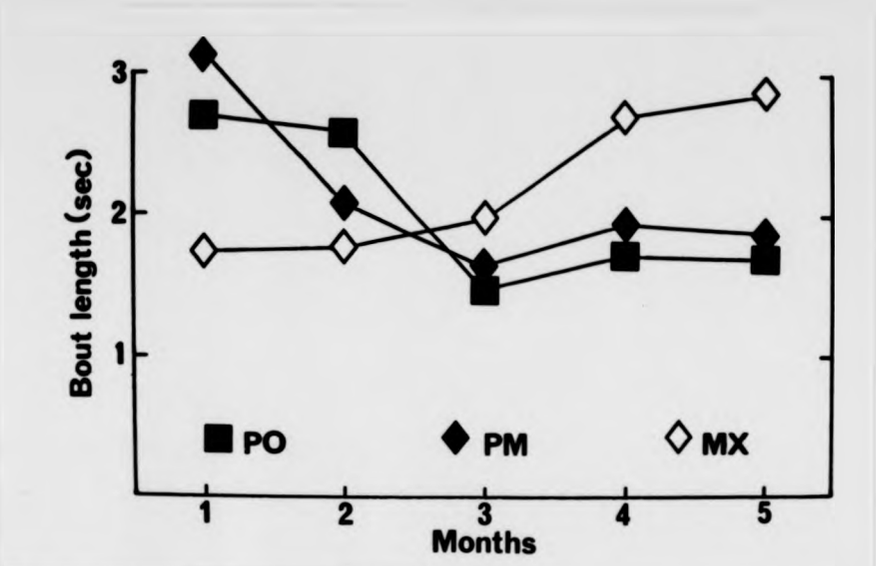

Figure 18. Length of peer-directed Contact Exploration bouts.

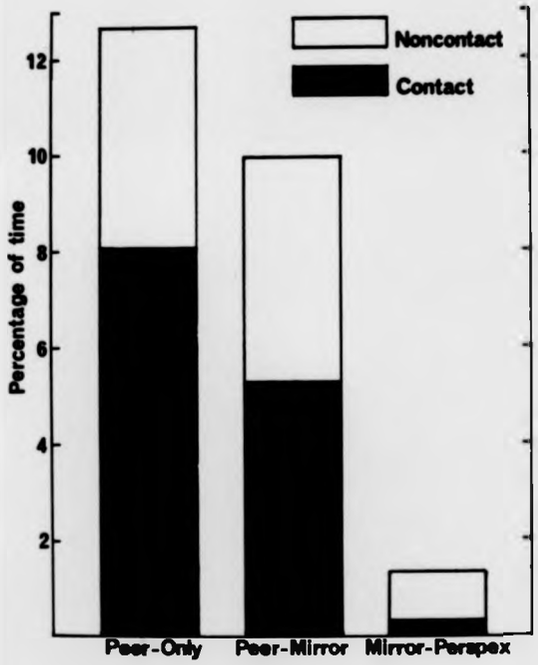

Figure 19.
Amount of time in peer-directed play.

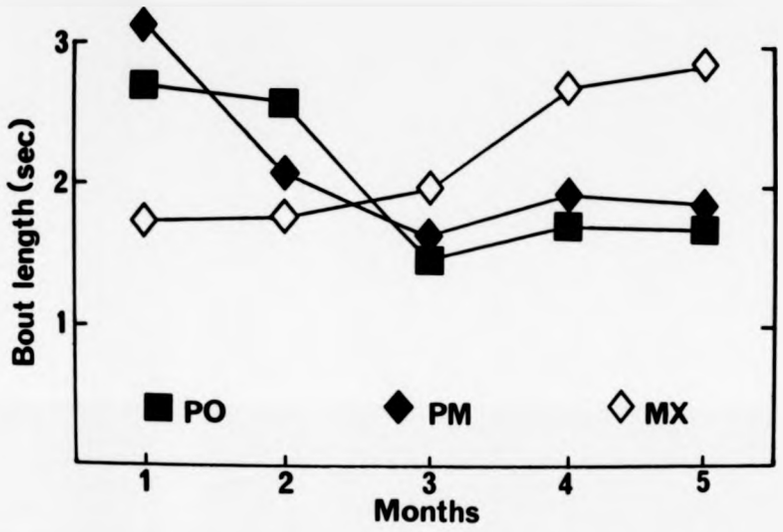

Figure 18. Length of peer-directed Contact Exploration bouts.

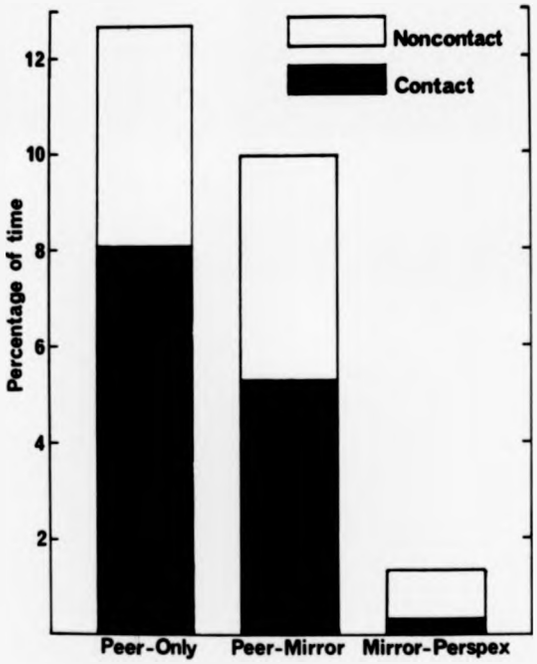

Figure 19.
Amount of time in peer-directed play.

did not reach significance ($p = .076$).

Some of the above trends were confirmed when the percentage of time spent in aggressive behaviour was examined. The PM pair was involved in aggression more of the time than was MX pair, $F(2, 3) = 11.0$, $p < .05$. Overall pair means did not exceed 0.2% of time, affirming that aggression was rare, but aggression increased every month. Again, it seemed that peer-housed animals in particular were more prone to engage in aggression in later months (Pair X Months, $p = .063$).

Peer-directed affiliation also did not occur at high rates. When it did occur, it tended to involve contact ($p = .051$), but neither rate nor percentage of time measures yielded any other noteworthy effects. Contact Affiliation bout lengths were analyzed by averaging over months, but no differences among the pairs were found.

3. Play. SUMMARY: Social play was more frequent, and accounted for more time, in animals housed with a fully accessible peer than in animals for whom physical access was prevented by a Perspex partition. PO animals, in particular, exhibited relatively high levels of Contact Play.

Animals with physical access to a peer, i.e., PO and PM pairs, engaged in more frequent bouts of social play than did MX animals, $F(2, 3) = 22.4$, $p < .025$ (mean rates per 5 minutes: PO, 16.0; PM, 13.4; MX, 2.5). This trend was not influenced by months or form. Noncontact Play was more frequent than Contact Play.

The Pairs main effect was also prominent when amount of time spent in play was considered, $F(2, 3) = 26.5$, $p < .025$, but now there was an interaction with Form, $F(2, 3) = 10.3$, $p < .05$. It emerged that only PO pair engaged in reliably more play involving contact than in Noncontact

Table 8. Summary of significant Pair effects in peer-directed activity.

Behaviour	Parameter	Result	Prob.	Comments
Exploration	Bout length	Month 1: PO+PM?MX Month 2: PO > MX Month 3: No differences Month 4: PO+PM<MX Month 5: PO+PM<MX	.005	Only the Pair X months X Form interaction reliable. No differences in Noncontact Exploration. Results refer to Contact form
Aggression	Percentage of time	PM > MX	.05	Only the Pair main effect reliable
Play	Rate	PO + PM > MX	.05	Only the Pair main effect reliable
Play	Percentage of time	Contact: PO?PM?MX Noncontact: PO+PM?MX	.05	The main effect also reliable: $p < .025$, PO+PM>MX
Affiliation		No differences		
Total	Rate	PO + PM > MX	.05	Only the Pair main effect reliable

Play (8.1% versus 4.6%, LSD = 2.1). Also Contact Play in PO animals accounted for more time than in PM animals, and of course more than in MX pair, whose overall mean was only 1.4% (see Figure 19). There was a suggestion of play being most common in Month 3, and slightly below average in the last two months, but the trend did not attain significance ($p = .054$), nor did Months X Form ($p = .052$).

Since play toward the peer behind Perspex was sometimes very infrequent, bout length of play episodes was analyzed by averaging over months, but retaining Form as a variable. The Pairs effect was not significant. In all three pairs, Contact Play bouts tended to be of longer duration than Noncontact Play bouts.

4. Total responsiveness. SUMMARY: A fully accessible cagemate supported twice as much overall social behaviour as a peer behind a transparent partition.

Only effects involving the Pair variables are presented here. Summing over the four behaviours, rate of responding toward a true cagemate was approximately twice that of responding to a peer behind Perspex (37.4, 36.4, and 19.5 responses per 5 minutes in PO, PM, and MX pairs respectively), $F(2, 3) = 10.3$, $p < .05$. Although the amount of time spent in social behaviour was over twice as much in PO and PM animals as in MX animals, the effect was not significant ($p = .078$). Mean length of social behaviour episodes did not differ among the three pairs.

6.4 Comparisons of Activity toward a Mirror and a Peer behind Perspex in the MX Pair

Few of the analyses comparing mirror- and 'Perspex peer'-directed behaviours in MX pair revealed effects significant at $p < .05$. Some

effects had associated probabilities of between .05 and .10. These will be briefly described, provided that they involved the Time variable. Otherwise only statistically reliable effects are presented in the text. All F values occurring at less than p = .10 are available in Appendix 5.

1. Exploration. SUMMARY: There were no clear-cut differences in exploration of the mirror and the peer behind Perspex. The data suggested a slight superiority of the mirror image in eliciting exploration, but individual bouts of social exploration tended to be slightly longer in the Perspex condition, especially Contact Exploration bouts in the last two months.

The mirror elicited slightly more instances of exploration than did the peer behind Perspex (p = .082), and slightly more total exploration (p = .091), but these trends were not significant. As expected, Non-contact Exploration was clearly the more common form. There was weak evidence of longer exploratory bouts toward the peer behind Perspex (p = .068), and the Months X Time interaction (p = .054) suggested that this was most apparent in the last two months, when Perspex peer exploration bouts averaged over 2 seconds. In contrast, the longest mirror-directed explorations were in Month 1 (averaging 2 seconds). These trends applied mainly to Contact Exploration (highest order interaction: p = .056).

2. Aggression and Affiliation. SUMMARY: Aggression did not vary according to the type of social partner available to MX animals, and was always rare. Contact Affiliation was initially much more common with the mirror image than with the peer behind Perspex, but a decrease in Month 3 eliminated the difference.

Aggression, which was infrequent, was not notably different in the two conditions. The Months X Time X Form interaction in the percentage analysis occurred at $p = .088$, but no noteworthy trends were discernible.

Only one reliable effect emerged from the analysis of the rate of affiliation: Form, referring to a higher incidence of affiliation involving contact with the mirror or Perspex surface, than affiliation expressed without contact. In the percentage analysis, Months X Time X Form indicated that Contact Affiliation was 3-5 times more common toward the mirror than toward the Perspex peer in the first two months, $F(4, 4) = 16.4$, $p < .025$. However, mirror-directed affiliation dropped to Perspex peer-directed levels in the final three months, i.e., to 2% of time or less (see Figure 20). No differences between months or conditions in Noncontact Affiliation exceeded the LSD of 1.3.

3. Play. SUMMARY: Both rate and percentage of time measures favoured the mirror over the peer behind Perspex as an object of play. Noncontact Play, in particular, was more evident toward the mirror.

Social play was over twice as frequent in the mirror condition as in the Perspex condition (mean rates: 5.5 and 2.6 per 5 minutes), $F(1, 1) = 548.8$, $p < .05$. Mirror-directed play also accounted for more time, $F(1. 1) = 153.8$, $p = .0506$. Noncontact Play was the more common form on both measures. Time X Form indicated that while both forms of mirror play took up more time than corresponding Perspex condition behaviours, this was particularly true for Noncontact Play, which reached 2% in the mirror condition, and 1% in the Perspex condition, $F(1, 1) = 480.6$, $p < .05$.

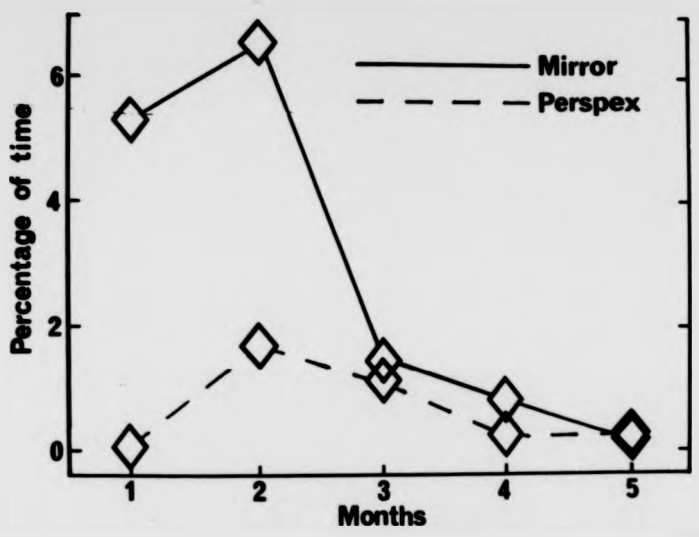

Figure 20. Amount of time in Contact Affiliation with own mirror image and a peer behind Perspex in MX pair.

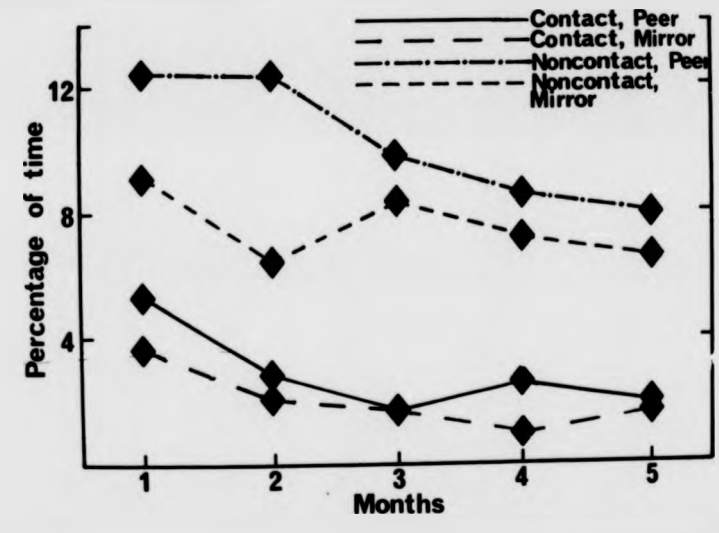

Figure 21. Amount of time in exploration of own mirror image and a live cagemate in PM pair.

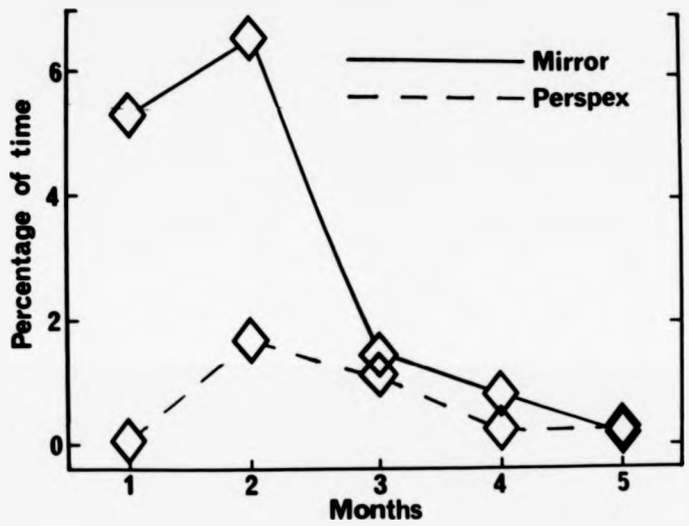

Figure 20. Amount of time in Contact Affiliation with own mirror image and a peer behind Perspex in MX pair.

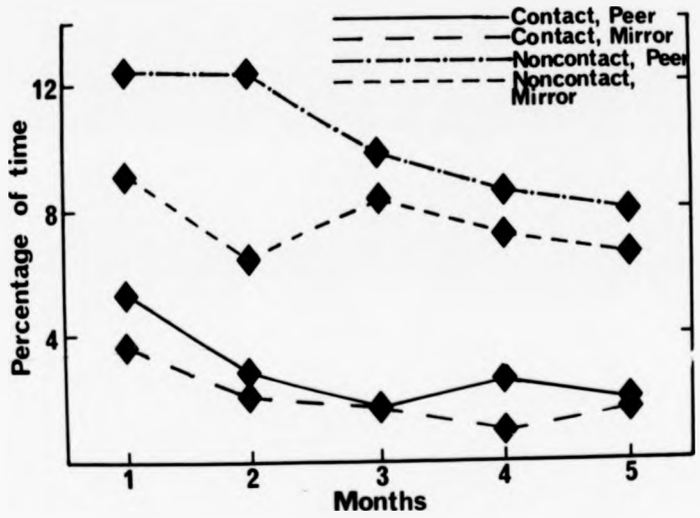

Figure 21. Amount of time in exploration of own mirror image and a live cagemate in PM pair.

4. Total responsiveness: SUMMARY: Mirror-directed responses were more frequent, but not more time consuming than Perspex peer-directed responses.

Combining the four behaviours previously discussed, behaviour toward the mirror occurred at a higher rate than toward the peer behind Perspex (means 23.5 and 19.5 respectively), $F(1, 1) = 27170$, $p < .01$. The total time spent in behaving with the two stimuli was not significantly different (mirror: 15.4%, Perspex: 11.2%). Mean bout length of the composite behaviour category did not differ in the two conditions.

6.5 Comparisons of Activity toward a Cagemate and a Mirror in the PM Pair

As in the previous section, effects occurring at less than $p = .10$ will be described if they involve the Time variable.

1. Exploration. SUMMARY: In the early months PM animals explored the cagemate for more time than they explored the reflection. The difference tended to disappear as exploration of both types of social partner decreased. Rate and bout length measures never differentiated the two conditions.

The main Time effect was not significant in either the rate, or the percentage of time analyses. Noncontact Exploration was over 4 times frequent than Contact Exploration, and accounted for over 3 times as much time. A significant Months X Time X Form interaction, $F(4, 4) = 6.7$, $p < .05$, showed that peer-directed Contact Exploration accounted for more time than the mirror-directed equivalent in Month 1, when the means were: peer: 5.4%, mirror: 3.7%, LSD = 1.5. This activity declined in Month 2 in both conditions, and thereafter remained at low levels

(Figure 21). In Month 1, Noncontact Exploration was also more pronounced in the peer condition than the mirror condition (means of 12.4% and 9.2% respectively), and this difference also eventually disappeared. The average length of individual episodes of exploration never differed between the two stimulus conditions.

2. Aggression and affiliation. SUMMARY: Aggression was more common toward the mirror than toward the cagemate in Month 4, but this was reversed in Month 5. Measures of affiliative behaviour did not reliably differentiate the two conditions.

A Months X Time interaction, $F(4, 4) = 31.9$, $p < .005$, indicated that aggression was more frequent toward the mirror than the cagemate in Month 4, but that the reverse relationship was obtained in Month 5. The percentage analysis told a similar story, $F(4, 4) = 20.7$, $p < .01$. Contact Aggression was slightly more common than Noncontact Aggression ($p = .058$).

Affiliative behaviour was not detected as being reliably different in the two stimulus conditions. It occurred 4% of the time with the cagemate, and 2% of time with the mirror. Due to the rarity of aggressive and affiliative behaviours in some months, bout lengths of these categories were not analyzed.

3. Play. SUMMARY: Although there were trends favouring the true peer as an object of play, in terms of rate, percentage of time, and bout durations, all of these effects fell short of significance.

There was a slight tendency for play to be exhibited more frequently toward the peer than the mirror, but not significantly so ($p = .097$). Noncontact Play was clearly the more frequent form in both conditions.

Peer-directed play was twice as common as mirror-directed play in terms of percentage of time devoted to the behaviour (10% and 5% respectively), but the difference did not attain significance ($p = .067$). Bouts of peer play (2.3 seconds) were on average slightly longer than bouts of mirror-directed play (1.7 seconds), and this seemed to be so particularly in the first three months. This Months X Time interaction also failed to reach significance ($p = .066$). The longest monthly mean bout for mirror-play did not exceed the shortest for peer-play.

4. Total responsiveness. SUMMARY: Contact behaviours were twice as common toward the cagemate as toward the reflection.

Surprisingly, the only reliable effect from analyzing the rate of the 'total' category was Form: Noncontact activities predominated over those involving contact. Although the percentage of time animals engaged in peer-directed behaviour appeared considerably larger than the corresponding mirror score (27.6% versus 16.8%), the difference was not reliable. However, a significant Time X Form interaction, $F(1, 1) = 252.3$, $p < .05$, indicated that the difference between the two stimulus conditions was greatest in terms of Contact behaviours, the peer value being over twice the mirror value. Mean behavioural bout lengths did not differ notably in the two conditions.

6.6 Overview of Results from Home Cage DTU Weekday-Weekend Comparisons

In the way of a summary of overall social responsiveness in the four pairs of subjects, Figure 22 has been constructed. It presents the percentages of time devoted by each pair of subjects to the three major social behaviours, namely Exploration, Play, and Affiliation, as well as the Total category, which also includes the infrequent Aggression. Of

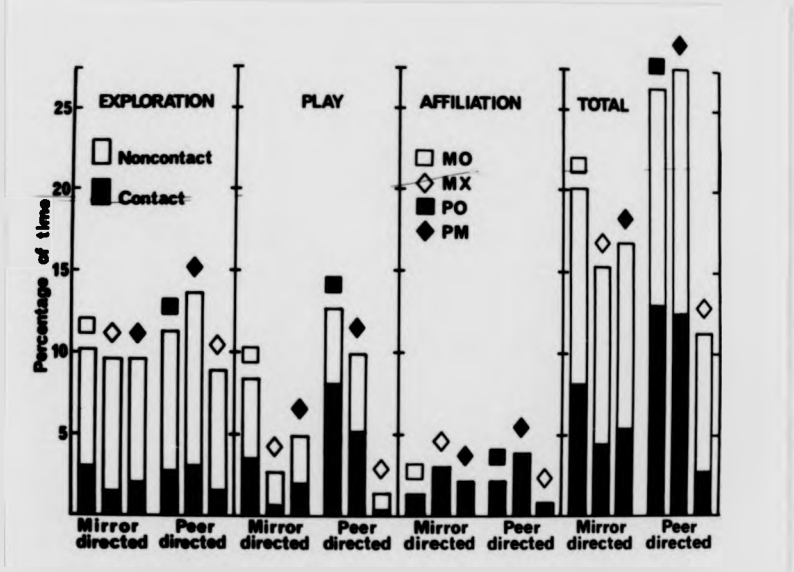

Figure 22. Amount of time in social behaviours in different conditions.

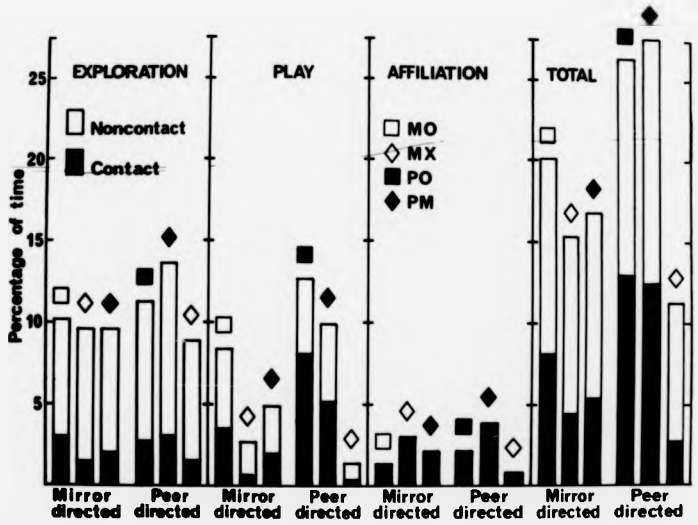

Figure 22. Amount of time in social behaviours in different conditions.

course the differential effects of months on these behaviours is not discernible from the figure.

The results reported in the present chapter extend the information about the social conditions obtained in earlier chapters. Some of these results were both unanticipated and intriguing. For example Contact Affiliation with one's mirror image clearly predominated over Noncontact Affiliation, despite the impossibility of achieving conventional 'contact comfort' from a mirror. This suggests that affectional responses may persist in the absence of the normal sensory consequences in infant macaques, and that vision alone is an important elicitor of affectional responding. Of course evidence presented earlier also indicated that mirror- and peer-attachments were not truly equivalent.

Other results were more surprising, such as MX animals spending less total time engaging in social behaviour toward the mirror than MO pair. In this respect, MX pair behaved rather like PM pair, whose mirror experience was supplementary to real peer experience. Analysis of individual behaviours revealed that this effect was largely due to differences in social play. In fact mirror-directed play in MX pair was rarer than in PM pair. In some other respects too, e.g., initial length of social exploration bouts, and length of play episodes, MX animals tended to resemble the PM pair, and showed less responsiveness to the mirror than MO pair.

In terms of one of the questions presented at the beginning of the chapter, it would appear that the additional social experience given to the MX pair (i.e., a peer behind Perspex), resulted in a 'dampening' of their responsiveness toward the mirror, compared to animals whose entire social experience was in the form of MIS (MO pair). However, both MO and MX pairs exhibited markedly longer Contact Affiliation bouts with the mirror than did PM animals, whose mirror

experience was supplementary to peer experience. This illustrates that different behavioural systems are not equally affected by varying early social experiences.

In comparing MX pair's Weekday and Weekend behaviours, it was found that they exhibited more Contact Affiliation toward the mirror than toward the peer behind Perspex in the early months. Social exploration provided an ambiguous picture, i.e., no clear differences, but some weak evidence of more exploration of the mirror countered by longer individual bouts of 'Perspex peer' exploration in later months. By summing over behaviours it was demonstrated that responses toward the mirror image were more frequent that toward the Perspex partner, but not more time consuming. On the basis of the available evidence, the following statement appears reasonable: Although three days per week experience of a peer behind Perspex diluted responsiveness toward the mirror in MX animals relative to MO monkeys, it was not the case that the peer behind Perspex received more social behaviour. In fact the mirror tended to attract more social reaction than did the Perspex peer. This issue is taken up further in the Discussion (Chapter 9).

PM animals generally responded less toward the reflection than did MO animals, possibly indicating that for the relatively sophisticated peer-reared infants, the mirror was perceived as a stimulus of limited social potential. Further evidence that the mirror represented an 'inferior' social partner to PM animals comes from analyses of this pair's behaviours in the two stimulus conditions. Both Contact and Noncontact Exploration initially occurred more often toward the true peer, the difference between this social partner and the mirror only diminishing as social exploration decreased over months in both conditions. Also, while play measures did not reveal significant differences between the two conditions, the non-significant trends suggested the true cage-

mate as a better stimulus for engaging in play. Clearly, however, the mirror image was perceived as a social stimulus to some extent by the PM pair, since aggression, affiliation, and play were all directed toward it at various stages. Also, in some respects, e.g., rate of Contact Exploration, PM pair responded much like the mirror-reared pairs. Finally, the slight increase in length of PM pair's social exploration bouts in Month 5, leaves open the possibility that at a certain stage of development, some behaviours of socially sophisticated animals might be exaggerated in front of a mirror. It may also be noted that in the highly responsive MO pair, some aspects of behaviour decreased over months, while others, e.g., rates of Noncontact Exploration and Noncontact Play, tended to increase. This also suggests that MIS can have multiple effects, depending upon the exposure period and the measures used.

As might be expected from the preceding discussion, a peer behind Perspex received weaker social reactions than a fully accessible cagemate (MX pair compared to PO and PM pairs). The main differences between the two conditions were in play activities, underlining the importance of bodily contact in the maintenance of play. One unexpected and interesting finding was that in contrast to the decreasing length of bouts of Contact Exploration in peer-reared animals, in MX animals the equivalent parameter increased over months. This might suggest some growing interest in the peer behind Perspex with increasing age.

From the generally close similarity in behaviour between the two peer-reared pairs of monkeys, it can be concluded that the additional social experience (MIS) given to PM animals did not have much influence on their home cage social behaviour with the cagemate. The only difference between the pairs was that PO animals engaged in

relatively more Contact Play, but there was no other evidence of a possible 'dampening' effect on behaviour (see above with reference to MX animals).

Up until now analysis of the infant monkeys' behaviours has been focused entirely on behaviour occurring in the home cage. The next two chapters concern the effects of the rearing conditions on behaviour exhibited in other situations.

CHAPTER SEVEN. RESPONSES TO UNFAMILIAR ENVIRONMENTS, AND TO PICTURES OF CONSPECIFICS

7.1 Introduction

When the subjects reached 7 months of age they were started on a series of tests aimed at investigating the effects of their various rearing conditions in other, more controlled situations. Aspects of emotionality, responsiveness to different types of social stimuli, and reactions to mirror image stimulation were assessed. This chapter describes two of the most important experiments of the series. Each experiment to be reported in this chapter and the next is presented with its own Introduction, Methods, and Results sections. The implications of the findings are considered, along with findings already documented, in the Discussion chapter (Chapter 9).

7.2 Reactions to Unfamiliar Environments

1. Introduction. Intense emotional reactions to an 'open field' situation were illustrated in early reports of the effects of different rearing conditions in monkeys (e.g., Harlow and Harlow, 1962). Infant rhesus monkeys were observed to derive some security from a cloth surrogate mother in the unfamiliar environment, using the surrogate as a base from which to explore the environment. In marked contrast, infants derived no comfort from the presence of a bare wire-frame surrogate, even if it was familiar to the infants. Under such circumstances the infants exhibited gross disturbance and fear, engaging in self-clinging and 'freezing' postures. Thus responses in unfamiliar settings can be used to assess attachments.

Responses to novelty can also be used to test general adaptability or adjustment. Sackett (reviewed in 1973b) tested 3- to 5-

year old rhesus from various rearing conditions, with respect to adaptation to novel stimuli. Animals reared in isolation for at least the first 6 months of life were more reluctant than socially reared controls to enter a novel environment. They also explored a neutral nonsocial stimulus less, and engaged in less locomotion around the test cage than did controls.

Some studies have also obtained data on reactions to unfamiliar environments as part of a larger social separation paradigm. One study which is of particular interest in the present context will be mentioned here (Brandt et al., 1972). Seven-month old rhesus infants were used, and a condition of separation from the home cage in isolation-reared infants was included. In brief, when in the unfamiliar environment (a large cage in another room), isolates exhibited less locomotion, slightly less self-play, more coo vocalizations (but still less than mother-reared controls), and more self-directed activity than in the pre-separation phase. Generally, isolates' behaviours appeared less disrupted by the separation experience than those of mother-reared infants.

Studies of the type mentioned above indicate that behavioural reactions to separation/unfamiliarity can provide information regarding the functioning of systems concerned with adaptation and adjustment. Two experiments were carried out in the present study to examine whether the rearing conditions employed had discernible differential effects on adaptation to novel, nonsocial environments. Firstly, the animals were tested over four days days for reactions to a moderately novel environment, namely, a slightly larger and differently designed home cage in a familiar room. Then the animals were tested in a completely novel environment, i.e., a much larger cage situated in an entirely unfamiliar room. The home cage checksheet was used to record behaviours in these environments, making it feasible to compare activity with that exhibited in the home cage.

It was possible to set up two opposing predictions regarding the above experiments. On the one hand it might be expected that animals reared with true social experience (peer-reared group) would adapt more rapidly and efficiently to the unfamiliar environments than would animals reared without physical social contact (mirror-reared group), since the latter group might be more 'emotional' (e.g., Mason, 1968; Sackett, 1973b). On the other hand, since for the peer-reared group the novel environment test sessions would involve cagemate separation, to which they would react with agitation (Brandt et al., 1972; Suomi et al., 1970; see Chapter 4), they might be more disturbed in unfamiliar surroundings than would less attached mirror-reared animals. Data on the two Alone animals were also collected for comparison purposes.

2. Methods

(i) New home cage test. On the first Monday after a subject reached 7 months of age, the Experimenter removed the subject and its diaper by hand from the home cage, and placed them into a neighbouring cage (see Figure 23). This new home cage measured 66.3 X 58.8 cm., with height 68.8 cm. All six sides were made of 2.8 cm. square steel mesh. The front wall contained a 31 X 20 cm. mesh guillotine door. A water faucet was fitted in the back wall, a food hopper at the front, and an elevated spar running from front to back, 35 cm. from the cage floor. Although the new home cage was slightly larger and constructed of different materials, it provided the same amenities as the former home cage, including virtually the same view of the nursery.

For four consecutive days, the subject spent one hour daily on its own in the new home cage, during which time its behaviour was recorded. Behaviour sampling in these daily 1-hour sessions utilized the home cage checksheet and metronome system previously employed

during home cage testing. The procedure for recording behaviour was as follows: Immediately after placing the subject into the new home cage, the observer stepped back, sat down on a chair in full view of the subject, and began recording the subject's activity. This observation block lasted for 5 minutes, with 15-second intervals being signalled by the tape recorder. At the end of this block, the observer arose and quietly left the room. He returned and positioned himself again in time to record the subject's activity in the period 15-20 minutes after initial placement into the cage. This procedure was repeated so that data were collected for blocks 30-35 and 45-50 minutes after the subject's introduction to the new home cage. Thus for each subject, new home cage records were obtained in the form of modified frequencies, collected in four 5-minute samples per day, for four days.

In order to enhance adaptation to the new home cage, for those animals used to a mirror, i.e., the mirror-reared group and the PM pair, the new home cages contained mirrors as in the old home cages. The new home cages into which PO animals were placed did not contain mirrors.

After behaviour sampling on the fourth day, the subject was not returned to the former home cage, but remained in the new one. If the subject was peer-reared, the cagemate was introduced into the same cage at this point. Thereafter, apart from daily removal for test sessions in the 'black cage' (see below), all subjects remained undisturbed in their new home cages for eight days. Normal Weekday-Weekend schedules were then reinstated. In this way, permanent housing in the new home cages, with the rearing conditions continuing, was achieved.

(ii) Black cage test. One week after initial introduction of a subject to the new home cage, adaptation to the 'black cage' began.

This cage is so called because of the colour of the mesh from which it is constructed. Situated in an otherwise empty room, the cage was wedge-shaped, 85 cm. wide at the narrow end, broadening to 280 cm. at the other end (Figure 23). The midline axis from one end to the other measured 198.5 cm. The cage was 140 cm. high, with the floor 55 cm. from the floor of the room. The cage floor, ceiling, and two convergent sides were of 5 X 2.5 cm. mesh. The open, narrow end of the cage was placed against a wall. The broad end wall of the cage was made of transparent Perspex. As shown in Figure 23, the amount and shape of space available inside the black cage could be varied by rearrangements of removable partitions. Usually, the cage was considered to consist of three main areas: Section 1 or 'exposure area', Section 2 or 'central area', and Section 3 or 'choice chambers'. An animal in any of the choice chambers could not see into another chamber, since the dividing walls were of opaque white Perspex. From the exposure area an animal could view across the central area into all four choice chambers. In the central area the number of choice chambers which could fully be seen became restricted to two.

Initial experience of the black cage consisted of four daily 1-hour sessions (as for the new home cage), during which the subject was free to explore cage sections 1 and 2. Physical access to the choice chambers was prevented by two transparent partitions which came together at the vertical midline. There were no mirrors available to the animals.

Behaviour during these four daily sessions was recorded in the same way as in the new home cage sessions, with the observer sitting 1.5 metres away from the cage, and vacating the room between each observation block. At the end of the hour long session, the infant was picked up with its diaper and returned to its home cage.

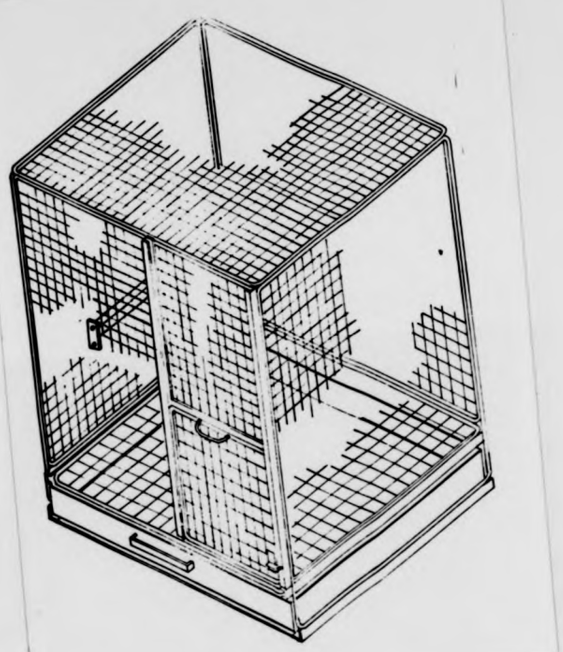

Figure 23. Drawing and picture of a new home cage. In the picture, the cage is fitted with mirrors, one of which is visible at the back. (Drawing by J.Russell).

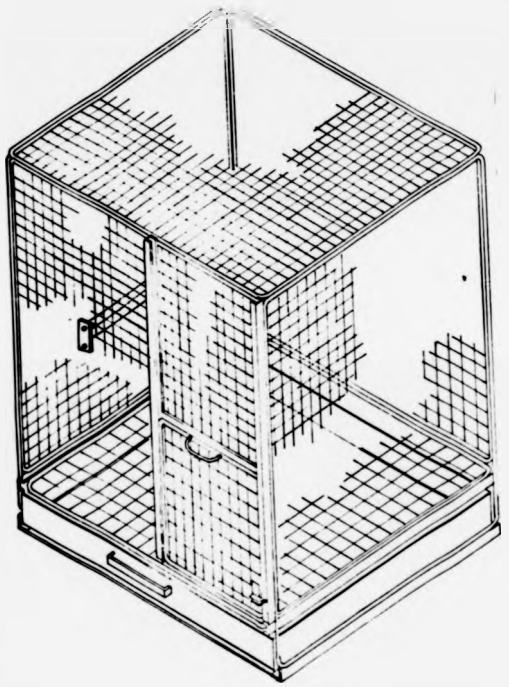

Figure 23. Drawing and picture of a new home cage. In the picture, the cage is fitted with mirrors, one of which is visible at the back. (Drawing by J.Russell).

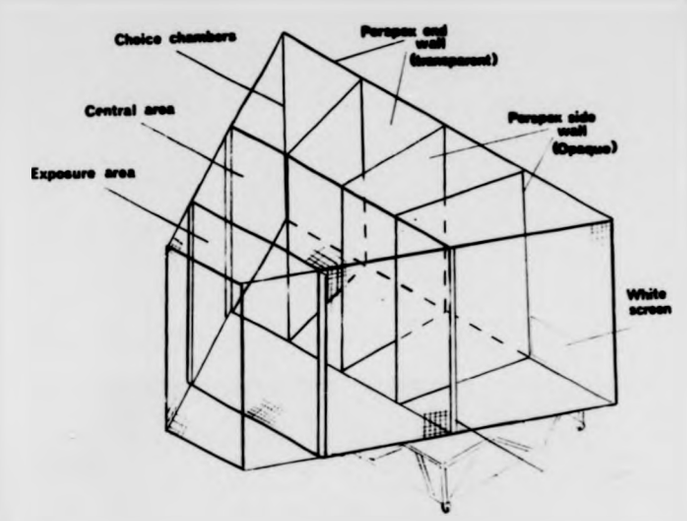

Figure 23 (contd.). Drawing and picture of the 'black cage', used for tests. The picture shows the choice chambers. (Drawing adapted from original by John Russell).

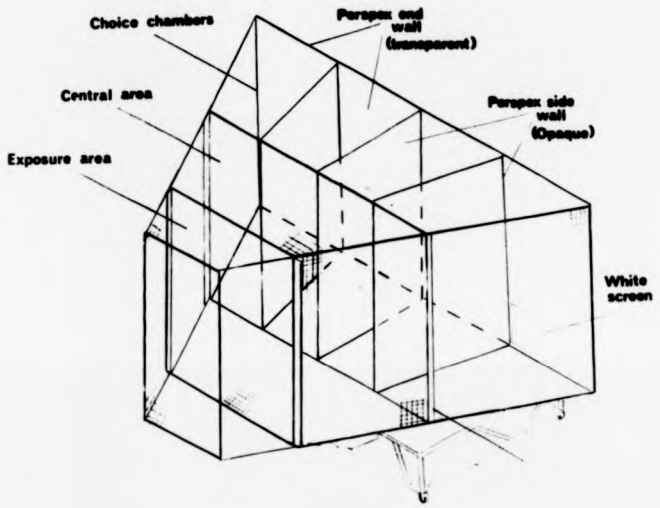

Figure 23 (contd.). Drawing and picture of the 'black cage', used for tests. The picture shows the choice chambers. (Drawing adapted from original by John Russell).

(iii) Analysis. Analyses of variance were performed on the data, with Social Partner during rearing as the between subjects variable, and with behaviours combined in analyses as in the earlier analyses of home cage checksheet data (Chapter 4). In all analyses, Days of testing (1, 2, 3, or 4), and Blocks (1, 2, 3, or 4) were within subjects variables. 'Environment' (new home cage or black cage) was a within subjects factor in all analyses except one. Individual alterations of the anova format are described where appropriate in the Results section. As in earlier analyses, alpha was set at .05, with subsequent LSD tests considered appropriate only for significant effects. All significant effects involving the Social Partner variable are reported below. To save space, however, only significant main effects of within subjects variables are reported. F values for these latter effects, and all other significant Fs, are available in Appendix 6.

3. Results.

(i) Environment- and self-directed activity. SUMMARY: Self-orality was particularly characteristic of the peer-reared group in the two unfamiliar environments. On Day 1 in the highly unfamiliar environment, activity was lowest in the mirror-reared group but highest in the peer-reared group. In the moderately unfamiliar environment, the peer-reared group generally exceeded the mirror-group in activity. The two Alone animals mostly resembled the mirror-reared group, but were less active, and engaged in less self-orality but more Oral Environment, than the two main groups.

Four of the five within subjects variables yielded reliable main effects in the analysis of the three behaviours Manipulate, Oral, and Aggress. These were Environment: animals were more active in the less unfamiliar

setting (new home cage) than in the very unfamiliar environment (black cage); Days: there was less environment- and self-directed activity on Day 1 in the novel environments than on Days 2 and 3, and less on Day 4 than Day 3; Blocks: there was less activity in the first 5 minutes of daily tests than in subsequent blocks; and Behaviour: the categories Manipulate and Oral were much more common than Aggress. Environment-directed activity tended to be more common than self-directed activity ($p = .07$).

There was no significant main effect of Social Partner in this analysis, but Social Partner X Behaviour was reliable, $F(2, 12) = 5.4$, $p < .025$. The peer-reared group's oral activity exceeded all three behaviours in the mirror-reared group, as well as its own manipulation and aggression. Social Partner X Environment X Days, $F(3, 18) = 4.5$, $p < .025$, can be described as follows: Within the two groups, overall manipulatory, oral, and aggressive activity never varied across test days in the new home cage. In the black cage, however, activity was lower on Day 1 than on subsequent days in the mirror-reared group, but lower on Day 4 than on previous days in the peer-reared group (Figure 24). Both groups were less active in the black cage than in the new home cage.

Figure 24 also shows that there was substantial day-to-day variability in the two Alone subjects, and that unlike the two main groups, these animals did not always exhibit less activity in the very unfamiliar environment. In the less unfamiliar (new home cage) setting, activity was generally greater in the peer-reared group than in the mirror-reared group. In the more unfamiliar, black cage, however, this trend held only for the first day. In the new home cage, Alone-reared subjects tended to be less active than the main groups. Peer-reared animals exceeded Alone animals in activity on Day 1 in the black cage, but the reverse occurred on Day 4.

Although the behaviours tended to increase slightly after the first observation block each day in the mirror-reared group, this trend was more marked in the peer-reared group. This Social Partner X Days X Blocks interaction was reliable, $F(9, 54) = 2.1$, $p < .05$. It may be noted that the Alone subjects exhibited no such pattern of increased activity between Blocks 1 and 2: there was an increase on two of the days, a decrease on one day, and no change on the other.

Also reliable were Social Partner X Days X Blocks X Direction, $F(18, 108) = 1.7$, $p < .05$, and Social Partner Behaviour X Blocks X Direction (Environment or Self), $F(6, 36) = 4.8$, $p < .0025$. Aggression never differed between mirror- and peer-reared groups across blocks or in direction. Manipulate and Oral means are plotted in Figure 25, along with the corresponding means for the two Alone subjects. It can be seen that self-manipulation never differed between the two main groups, nor within these groups across the four blocks (LSD = 1.3). Environmental manipulation, which was always 4-5 times more common, differed between the two groups only in Block 1. Specifically, peer-reared animals were less likely than mirror-reared animals to manipulate the environments when first placed in them each day. However, this activity increased in peer-reared animals in the second block, eliminating the difference.

Turning to oral behaviour (Figure 25, right panel), in neither group did oral contact with the environment vary over blocks. Marked differences emerged in self-orality. Generally, self-orality was twice as common in the peer-reared group as in the mirror-reared group. Peer-reared animals exhibited a large increase in self-oral behaviour between Blocks 1 and 2, and smaller increases in subsequent blocks. Mirror-reared animals also showed the increase in Block 2, but in Block 4 self-orality was down to original levels.

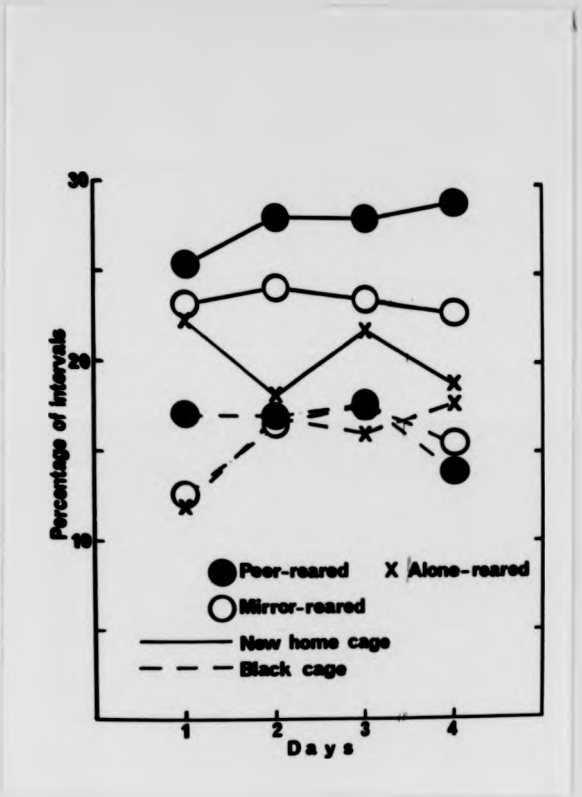

Figure 24.
Activity in two novel environments. Scores are averaged over the behaviours Manipulate, Oral, and Aggress.

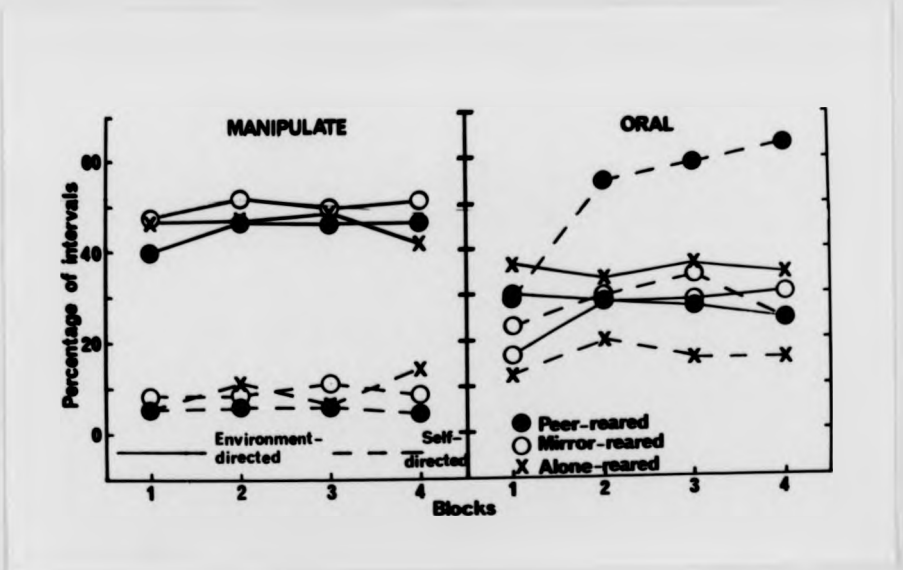

Figure 25. Manipulatory and oral activity in novel environments.

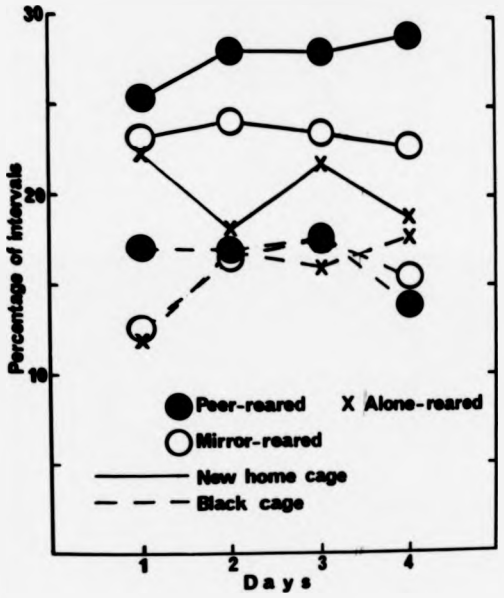

Figure 24.
Activity in two novel environments. Scores are averaged over the behaviours Manipulate, Oral, and Aggress.

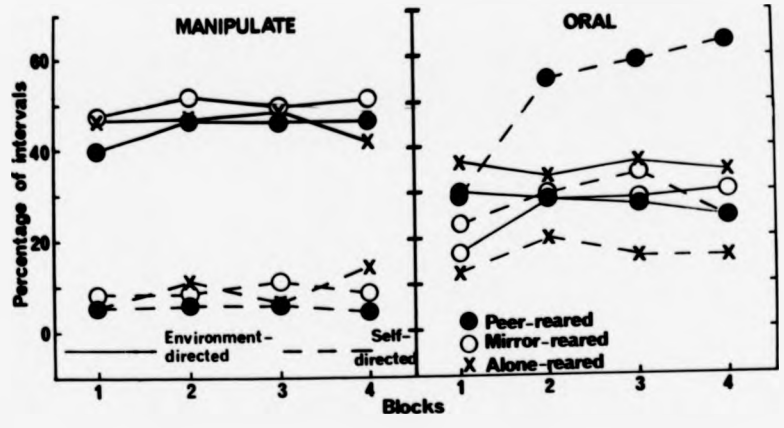

Figure 25. Manipulatory and oral activity in novel environments.

The picture regarding oral behaviour in the two Alone subjects is also interesting. Oral Environment in these animals tended to be more common than in both mirror- and peer-reared groups, whereas self-orality was substantially less evident.

(ii) Diaper-directed activity. SUMMARY: Overall, the peer-reared group engaged in more diaper-directed activity than did the mirror-reared group, particularly in the very unfamiliar, black cage. Although the mirror-reared group and the Alone pair increased looking at the diaper in the black cage, the peer-reared animals exhibited large increases in behaviours involving physical contact with the diaper. Alone-reared subjects also clasped the diaper more in the black cage.

In the more unfamiliar, black cage, diaper-directed behaviour was almost three times as common as it was in the less unfamiliar, new home cage. This Environment effect was the only within subjects effect to reach significance. It interacted with Social Partner, $F(1, 6) = 51.1$, $p < .0005$, as did Behaviour, $F(2, 12) = 11.5$, $p < .0025$. The composite Social Partner X Environment X Behaviour effect, $F(2, 12) = 8.3$, $p < .0075$, is illustrated in Figure 26. Looking at the diaper increased markedly from the new home cage to the black cage in mirror-reared, but not peer-reared animals. The two Alone subjects also exhibited this increase. However, behaviours involving physical contact with the diaper, namely manipulation and clasping, both increased sharply in the black cage in peer-reared but not mirror-reared subjects, resulting in scores 3-6 times greater than the mirror-reared scores.

The figure also shows that Alone-reared monkeys exhibited relatively high levels of Manipulate Diaper in the new home cage, and showed a slight decrease in the black cage. Like peer-reared subjects

they exhibited increased clasping of the diaper in the black cage, but the rise was not as marked as in the peer-reared group.

Figure 26 also shows the greater overall amount of diaper-related behaviour in the peer-reared group, with behaviours occurring in 15% - 68% of intervals, than in the mirror-reared group (0.6% - 23%); Social Partner main effect: $F(1, 6) = 19.0$, $p < .0075$.

One other effect involving the Social Partner variable was the interaction with Days and Behaviour, $F(6, 36) = 2.4$, $p < .05$. Look Diaper never varied across days in either group, nor between the groups on any day. In contrast, Manipulate Diaper more than doubled in the peer-reared group on Day 2, and remained high on Days 3 and 4 (Figure 27). This behaviour did not increase from Day 1 in mirror-reared animals. The differences between mirror- and peer-reared groups with regard to Clasp Diaper were in the same direction, but were even more considerable.

(iii) Locomotion and vocalization. SUMMARY: No differences between mirror-reared and peer-reared groups were obtained with regard to locomotion and vocalization in the novel environments. Vocalization was most prominent in the very unfamiliar environment.

Mirror- and peer-reared animals never differed in the amount of locomotion exhibited in the two unfamiliar environments. The means were: mirror-reared, 60% of intervals walking, and 59% climbing in the new home cage, and 63% and 31% in the black cage, respectively; peer-reared, 62% walking and 65% climbing in the new home cage, 65% and 34% respectively in the black cage. Alone subjects gave slightly higher scores: new home cage 68% walking and 69% climbing; black cage, 76% walking, 44% climbing. Only two within subjects main effects attained significance: There tended to be more locomotion in the first block

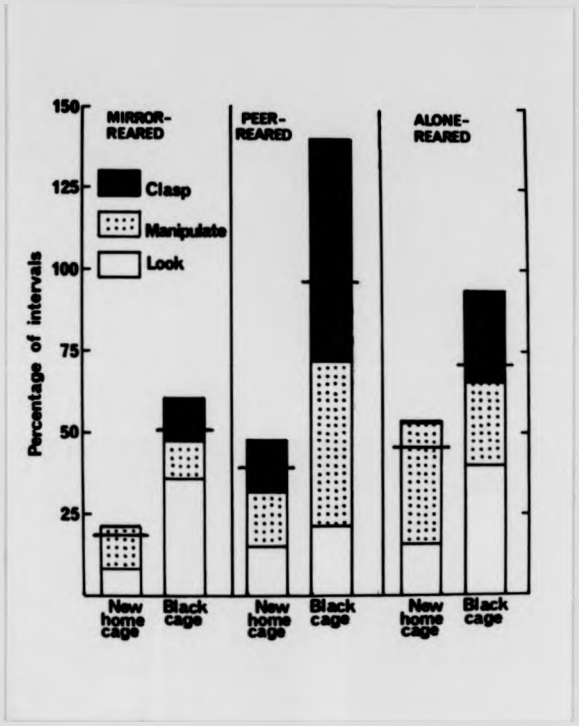

Figure 26. Diaper-directed activity in two novel environments.

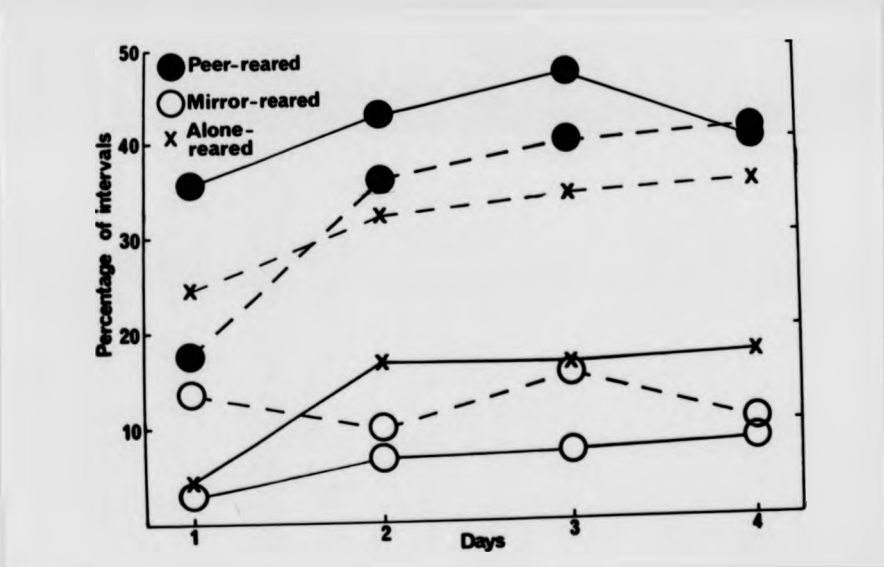

Figure 27. Diaper-directed activity over four days in novel environments. Solid line: Clasp; broken line: Manipulate.

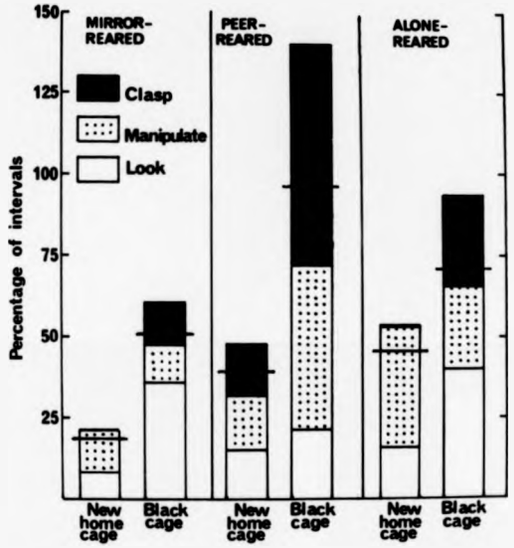

Figure 26. Diaper-directed activity in two novel environments.

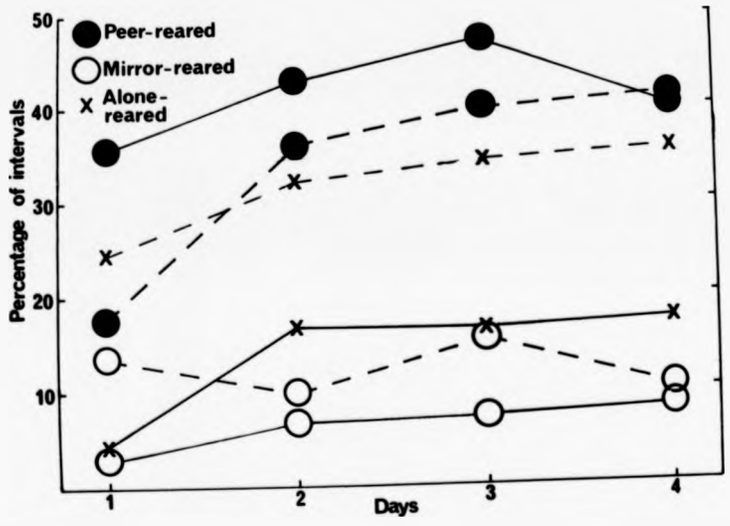

Figure 27. Diaper-directed activity over four days in novel environments. Solid line: Clasp; broken line: Manipulate.

than in subsequent blocks, and Walk was more frequent than Climb. The two Alone subjects also exhibited these trends.

Vocalization did not clearly differentiate the two main groups. There was a suggestion of more vocalization in the peer-reared group than the mirror-reared group during the first day in the new home cage. In the black cage, the peer-reared group seemed to vocalize less on the first day than on subsequent days, a trend which seemed slighter in mirror-reared and Alone subjects. However, the Social Partner X Environment X Days interaction from which these trends were taken was not significant ($p = .061$).

Both main groups of subjects were highly vocal in the more unfamiliar surroundings of the black cage, vocalizations occurring here in over 90% of intervals, compared to between 20% and 40% in the new home cage. This Environment main effect was highly significant. Alone subjects vocalized less, in 13% and 83% of intervals in the new home cage and the black cage respectively. One remaining main effect was that of Blocks, involving a gradual increase in vocalization rate over blocks. This effect was not so obvious in the Alone pair, although in these animals vocalization was least frequent in Block 1.

(iv) Play. SUMMARY: Play was prominent in the moderately unfamiliar environment, but virtually nonexistent in the grossly unfamiliar environment. The groups did not differ in play, which increased over blocks.

Play virtually never occurred in the black cage, so only the new home cage data were analyzed. In this moderately unfamiliar environment, mirror- and peer-reared animals exhibited similar overall amounts of play, and the two Alone subjects resembled the other animals in this respect. Environment-directed play occurred in 35% of intervals, self-

directed play in 9%, play tending to be more frequent in later blocks. A blocks effect was also apparent in the two Alone animals' data.

(v) The 'isolation syndrome'. SUMMARY: Autoeroticism, self-clasping, stereotypy, and bizarre postures were not very frequently observed, and did not differentiate the groups. These behaviours were most common in Block 1.

'Isolation syndrome' behaviours did not change markedly in the unfamiliar environments, the mirror-reared group performing these behaviours in 3% - 11% of intervals in the new home cage, and 5% - 13% of intervals in the black cage. Corresponding scores in the peer-reared group were 0% - 3% and 2% - 10%. Neither the differences between the groups nor environments were significant. These behaviours occurred in Alone animals in the new home cage in 1% - 8% of intervals, and in the black cage in 1% - 5% of intervals. Only the Blocks main effect clearly emerged, indicating that isolation syndrome behaviours were most common in the first block, gradually decreasing over subsequent blocks. This trend was also apparent in the data from the Alone pair.

(vi) Self-looking, drinking, and scratching. SUMMARY: Animals reared with mirrors engaged in Look Self more than did peer-reared animals, while the opposite was true for the category Scratch. Animals reared with no form of conspecific stimulation were the most prominent self-lookers, and scratched at an intermediate level.

Mirror-reared animals looked at themselves at over 3 times the rate of peer-reared animals (means 10% and 3% respectively), $F(1, 6) = 40.8$, $p < .001$. Alone reared subjects engaged in a higher rate still (16%).

Social Partner X Environment X Days X Blocks was also significant, $F(9, 54) = 2.3$, $p < .05$, but was not analyzed further. In both environments a bottle of milk was available to the subjects, but drinking was infrequent, and was not sensitive to any of the variables. The only clear effect of the analysis of scratching, was that it was over twice as common in peer-reared animals (5%) as in mirror reared animals (2%), $F(1, 6) = 12.4$, $p < .025$. Alone-reared subjects scratched in 4% of intervals.

(vii) Overview of novel environment results. In this section, reference will be made to some results from the home cage behaviour analyses (Chapter 4), to aid appreciation of the effects on behaviour of the two novel environments.

One clear finding in the present chapter was that peer-reared animals were more prone toward self-orality in the novel environments than were either mirror-reared or Alone subjects. They also engaged in more diaper-related behaviour than the mirror-reared group, especially in the very unfamiliar, black cage. The two main rearing groups could not be distinguished by measures of locomotion, vocalization, play, or 'isolation syndrome' behaviours. On the basis of the findings regarding self-orality and diaper contact, the proposition that peer-reared subjects might be more upset in the novel environments, due to the absence of their cagemates, seems to be at least partly supported, especially when the data from the black cage test is considered. There is no evidence to suggest that mirror-reared animals were more disturbed in these environments.

The question arises as to how behaviour in the unfamiliar environments compares with behaviour in the home cage. Note that the new home cage tests also incorporated Weekend housing conditions for peer-

reared subjects, while the black cage tests involved both a very unfamiliar setting as well as the loss of social partners for both main groups of subjects. The extent to which the reactions of the subjects to the novel environments are attributable to the loss of the social partner and to the unfamiliarity of the environments, can be better assessed with the aid of Table 9. The table contains group means for major behaviours in four conditions, namely, Weekday home cage housing; Weekend home cage; the moderately unfamiliar, new home cage; and the very unfamiliar, black cage. The home cage figures represent means for the final month of home cage testing (Month 5).

There are several interesting aspects of Table 9. Firstly, comparisons between columns 2 and 3 are particularly revealing. The Weekend home cage condition and the new home cage tests involved loss of the primary social partner for peer-reared subjects, whereas only the Weekend home cage condition involved this aspect with regard to mirror-reared subjects. It is therefore noteworthy that in both groups, and in the two Alone subjects, environment-directed activity was more prominent in the new home cage, while self- and diaper-directed activity were both lower. In fact the same relationship holds between the new home cage tests and Weekday home cage trends (column 1). Taking environment-oriented behaviour as a sign of positive response, and self- and diaper-directed behaviours as indicating negative reaction, these patterns suggest that the animals adapted quickly and positively to the moderately unfamiliar environment.

The above conclusion requires some qualification when additional aspects of the data are considered. For example play activity was consistently lower in the new home cage than in either of the previous home cage situations. In addition, vocalization was more evident in the new home cage than in the familiar Weekday home cage. Both of

Table 9. Homecage checksheet behaviours in four environments.[1]

Behaviour	Rearing Condition	Weekday Home Cage	Weekend Home Cage	New Home Cage	Black Cage
Environment-directed activity[2]	Mirror	22.9	20.2	36.2	16.8
	Peer	20.9	22.2	38.2	11.1
	Alone	22.8	18.5	34.4	20.1
Self-directed activity[2]	Mirror	19.0	20.5	10.5	14.3
	Peer	19.6	21.2	16.8	21.8
	Alone	11.7	15.5	5.9	11.0
Diaper-directed activity[3]	Mirror	12.8	9.3	7.2	20.2
	Peer	20.0	29.9	15.8	45.6
	Alone	19.0	20.8	18.1	31.7
Locomotion	Mirror	43.9	50.8	59.4	46.6
	Peer	51.5	49.9	63.3	49.2
	Alone	48.0	54.5	68.5	60.0
Vocalization	Mirror	20.3	21.4	23.4	94.1
	Peer	18.5	48.2	40.9	94.6
	Alone	8.0	16.6	12.7	83.4
Play Environment	Mirror	40.5	48.6	38.4	Almost never
	Peer	56.1	43.6	31.0	Almost never
	Alone	45.7	48.6	30.6	Almost never
Play Self	Mirror	12.3	12.8	10.4	Almost never
	Peer	12.0	9.9	6.1	Almost never
	Alone	31.1	31.0	8.4	Almost never
Isolation Syndrome[4]	Mirror	4.5	3.8	5.7	7.8
	Peer	3.6	3.8	1.7	4.3
	Alone	3.4	5.4	4.5	3.1
Look Self	Mirror	11.1	8.6	9.0	10.6
	Peer	5.3	5.2	3.7	2.7
	Alone	18.2	13.7	19.2	13.4
Drink	Mirror	3.7	6.4	3.4	3.7
	Peer	2.4	8.1	5.4	0.9
	Alone	0.4	3.5	3.0	4.4
Scratch	Mirror	6.2	6.1	3.1	0.9
	Peer	6.0	9.2	6.4	3.4
	Alone	0.6	2.6	6.4	1.3

Footnotes:

1. Scores are percentages of intervals during which behaviours were recorded. Weekday and Weekend home cage scores are means from Month 5 of home cage observations. New home cage and black cage scores are means over the four days of testing in each environment.
2. Scores are averaged over the categories Manipulate, Oral, and Aggress.
3. Scores are averaged over the categories Look, Manipulate, and Clasp.
4. Scores are averaged over the categories Autoeroticism, Self-clasp, Stereotypy, and Bizarre Posture.

these trends suggest some degree of negative affect in the novel environment. Taken together, the results point toward the elicitation of cautious exploration in the moderately unfamiliar new home cage, to some extent at the expense of play, which signals a confident animal. Note, however, that in peer-reared animals, vocalization rate in the new home cage was lower than during Weekend home cage housing, suggesting that the latter condition caused more agitation.

Locomotion provides an ambiguous picture. It was higher in the new home cage than in both Weekday and Weekend home cage situations. Such an increase could reflect heightened separation protest, due to the loss of the familiar environment. Alternatively, the increment in locomotion in the new home cage could represent exploratory behaviour. This latter interpretation receives support from certain aspects of the data described above. Locomotion was less frequent in the black cage than in the new home cage, even though the score was 'inflated' due to many instances of the subject scurrying from one location to another being classified as Walk. As discussed below, the black cage appeared to reduce other signs of adjustment.

Focusing upon column 4 of Table 9, it is clear that in the very unfamiliar environment play virtually disappeared, vocalization rate was extremely high, and diaper-directed behaviours reached their highest levels. Furthermore, in the black cage, environmental activity was reduced relative to the new home cage and Weekday home cage levels, while self-directed activity was higher than in the new home cage. These patterns combine to suggest that in the new home cage the animals generally exhibited behaviour suggestive of a moderate increase in arousal, with active exploration being elicited, and play at least remaining conspicuous. In contrast, in the highly arousing black cage, the animals emitted high rates of vocalization, engaged in self-directed

behaviours, and contacted their diapers more, with exploration and play being suppressed.

It may also be noted that the black cage produced the highest mirror-reared and peer-reared 'isolation syndrome' scores, but the opposite is true with the Alone animals. Some other differences between the rearing groups' scores are noteworthy, such as the decreasing rank order of Alone, mirror-reared, and peer-reared in Look Self in all four environments; the relatively low vocalization rate in Alone subjects; and the disappearance of the Alone pair's high Play Self score in the new home cage, while the corresponding difference in the two main groups were less marked. These trends will be more fully discussed in the Discussion (Chapter 9).

7.3 Interlude

1. Black cage adaptation. To facilitate adaptation to the black cage, in which subsequent tests were to be done, on the day following the final test day in the black cage test described above, the subjects remained in the black cage overnight, with normal amenities provided. After the first hour on this fifth day, the two Perspex partitions which had prevented physical access to the choice chambers were removed, thereby rendering the entire black cage available to the subjects.

The subjects' respective Weekday social partners were available overnight, i.e., peer-reared subjects were housed overnight with their own cagemates, and a mirror was present for mirror-reared subjects. The mirror, 22 X 25 cm., was placed against the transparent Perspex end wall of one of the four choice chambers, the particular chamber being chosen randomly on each of the three nights. Overnight illumination of the room in which the black cage was situated was from a 60 Watt electric Angle-poise lamp facing away from the cage. The subjects

were returned to their home cages between 0900 and 1000 hours the following morning, and were housed again in the black cage on the following two consecutive nights, making a total of three nights in the black cage.

Black cage adaptation programmes varied among animals as follows: Following the three nights of black cage housing, each mirror-reared and Alone-reared subject received a 1-hour individual adaptation session in the cage, every day for 30 consecutive days, i.e., until picture-choice tests commenced (see below). Two of the peer-reared animals also received these daily adaptation sessions, and then additional twice-weekly sessions for two months. The two remaining peer-reared subjects were given bi-daily adaptation sessions for two months. These variations were necessary due to the author's involvement in another project. All adaptation sessions involved the subject being placed in the black cage along with its diaper, with no social partner present. On the last day of adaptation, before the subject was placed in the cage, a 22 X 25 cm. white paper screen was attached to the Perspex end wall of each of the choice chambers.

2. Picture-choice tests. Each subject was given five picture-choice tests, one test per day, for five consecutive days. A test consisted of two trials, conducted 30-40 minutes apart. Briefly, during a trial, two different stimulus slides were projected, one each onto the screen at the end of the two central choice chambers, for a period of 2 minutes during which the subject was confined in cage section 1 by means of two transparent Perspex partitions (see Figure 23). During this time the infant's behaviour was recorded. One of the partitions was then partially withdrawn, allowing the subject access to the entire black cage including the four choice

chambers. The subject's position in the cage, and its behaviour were recorded for a further 5 minutes, using the DTU. Due to considerations of space, it has been decided to omit results of the picture choice tests from this report, and instead move directly to the picture-reaction tests (see below). It should be noted that three of the five picture-choice tests involved presentation of slides depicting stump-tail macaques. An infant, an adult female, and an adult male, all with neutral facial expressions, were portrayed on individual slides. Two days following the fifth picture-choice test, picture-reaction tests commenced.

7.4 Reactions to Projected Pictures of Conspecifics

1. Introduction. One as yet infrequently used technique in the study of the ontogeny and operation of social processes in primates, involves projecting pictorial stimuli and recording the responses of the viewing animals. Sackett (1965) introduced the use of slides to elicit social responses in monkeys. Advantages of the method were noted to include the ability to repeatedly present an identical 'social' stimulus, and the increased possibility of controlled variation of stimuli, to allow identification of critical features of a stimulus configuration. Sackett found that 3- to 4-year old rhesus monkeys responded differentially to different categories of slides. Socially-reared monkeys looked longer at slides of conspecifics than at nonmonkey slides, whereas isolates looked longer at slides of inanimate scenes or a human that at most of the monkey slides.

In subsequent experiments, Sackett (1966, 1973) recorded the responses of rhesus 'picture isolates' to slides projected onto a wall of their isolation chambers during rearing. Overall, responsiveness was greatest to pictures of infant monkeys and monkey threats than to

other slides, either of monkeys or nonmonkey scenes. Picture isolates did not respond differentially to pictures of monkeys exhibiting fear, withdrawal, exploration, sex, neutral posture, or mother-infant interaction. Between 2 and 4 months of age, disturbance behaviours and vocalization occurred at peak levels to pictures of threat only (although vocalization was always fairly frequent with infant pictures). From 4 months of age until the end of regular testing at 7 months, disturbance in the presence of threat pictures declined from this peak, but remained higher than in the presence of other slides. Pictures of infants and threats also elicited most play and exploration throughout the study. These findings were interpreted as evidence of predispositions toward responding to particular classes of stimuli, and as evidence of the visual threat stimulus acting as an 'innate releasing stimulus' akin to sign stimuli identified in other animals.

Following on from Sackett's work, Redican et al. (1971) tested socially-reared rhesus juveniles (2½ years old) in an operant conditioning paradigm in which slides could be obtained by lever pressing. Five facial expressions were depicted on the slides, which portrayed either adult or juvenile conspecifics. Some pictures of infants, and nonmonkey control pictures were also presented. While the subjects did not respond differentially overall for different ages of animals depicted on the slides, they did vary response rates according to facial expressions portrayed only on slides of juveniles. There were fewer lever presses to obtain pictures of threat and grimace than to obtain lipsmack, yawn, or plain face pictures. The results suggested that (a) macaques may dislike pictures of negative effect (e.g., grimace) rather than having a specific aversion to threatening stimuli, and (b) animals may be most responsive to pictures of agemates, rather than to pictures of infants (c.f. Sackett, 1966).

The final study to be considered here is by Haude and Detwiler (1976), who simply measured frequency and duration of the monkey placing

its head into a cage recess from which slides could be viewed. The subjects were 18-month old rhesus. They found more frequent looking at slides of unfamiliar conspecifics than familiar ones, but the duration measure proved not reliable. Only one difference was obtained with respect to the different behaviours depicted on the slides (intense threat, mild threat, grooming, submission, and neutral posture). Duration of looking at submission was greater than the corresponding score for grooming. Although Haude and Detwiler's results are unimpressive compared to those mentioned earlier, they do serve as a reminder that monkeys may look frequently at threatening stimuli (see also Butler, 1964; Humphrey and Keeble, 1974; Mitchell, 1972). Haude and Detwiler (1976) did not record any other behaviours.

There were two main aims of the picture reaction tests included in the present study. Firstly, the behaviours of infant stumptail macaques to coloured slides of conspecifics would be documented. To the author's knowledge this has not previously been done. Leonard (1980) employed slides in tests with 15-month old stumptails, and summarized the subjects' reactions with respect to their rankings on personality dimensions, but the responses were not reported in any detail. Secondly, the potential of a projected picture technique for distinguishing between groups of infant monkeys reared under different conditions would be assessed. Similar studies with rhesus monkeys (Sackett, 1972; Wood et al., 1979) have not employed slides of conspecifics in the stimulus series. The study by Sackett (1965) is an exception. He used adult subjects with extensive post-rearing social experience.

With regard to the issue of differences between rearing groups, it could be predicted that the more socially sophisticated, peer-reared animals would be more likely than mirror-reared animals to

differentiate among facial expression depicted on pictures, and to respond more appropriately. This prediction is based upon (a) the documented greater interest in conspecific material in socially-reared rhesus, compared to isolates (Sackett, 1965), (b) greater responsiveness to changes in visual stimuli in monkeys reared in a relatively stimulating environment (Wood et al., 1979), and (c) the presumed superiority of peer-reared animals in responding to social cues. On the other hand, it might be the case that the more socially naive, mirror-reared subjects would be highly sensitive to pictures of conspecifics (e.g., Sackett, 1966), while sophisticated, peer-reared monkeys might rapidly habituate to such artificial, static stimuli (see Humphrey, 1974). To investigate these issues, slides of infant and adult stumptails exhibiting different facial expressions were presented to the subjects. It was expected that infant pictures would elicit most exploration and/or social responses (Redican et al., 1971; Sackett, 1965). The two Alone animals were also tested.

2. Methods.

(i) Apparatus. The slide tests were conducted using one of the end choice chambers of the black cage as a test cage. An opaque white partition was inserted at the junction between the choice chamber and the central area of the cage (see Figure 23), confining the subject in the chamber. Data were recorded on the DTU using the same system as in the collection of home cage data. Slides were projected onto a screen attached to the end Perspex wall of the chamber, from a Rank Aldis Tutor 2 slide projector. Two sets of five slides were presented to each subject, one set in each session. Each slide gave a colour, frontal view of a stumptail macaque. Slides of adults showed the head and part of the upper torso; slides of infants showed the entire length of the body (see Figure 28). The projected images were approximately life size. Each set of slides contained one example of the following:

infant explore, infant fear, adult female explore, adult female fear, and adult male threat.

(ii) Procedure. To begin a slide-reaction test, the experimenter placed the subject along with its diaper into the test cage. The experimenter then prepared the DTU for the first trial, taking less than one minute. The slide projector was then switched on, at a moment when the subject was facing away from the screen. This resulted in the screen being illuminated. Following a period of about 30 seconds, the first picture was projected onto the screen, again at a moment when the subject was facing in the opposite direction. The experimenter then stepped over to his chair, sat down, and immediately began recording the subject's behaviour via the DTU keyboard. The chair was positioned 1.5 metres from the cage. At the end of the 3-minute trial, the experimenter stood up, walked over to the projector (a distance of about 2 metres), and switched it off when the subject was not looking at the screen. The next trial was then prepared, to start 2 minutes after the previous one had ended. Five trials, each involving a different slide category, were thus run, completing Session 1, after which the subject and its diaper were returned to the home cage. Session 2, employing the second set of five slides, was run the following day. In both sessions the order of presentation of the slides was random.

(iii) Analysis. Where sufficient data were obtained, they were analyzed by anova, with Social Partner during rearing as the between subjects variable. Session (1 or 2), Age of stimulus animal (infant or adult), Expression of stimulus animal (neutral or fear), and Form (contact or noncontact) were the within subjects factors. Data from the trials involving the adult male threat pictures were analyzed in separate anovas. As in earlier analyses, alpha = .05, and only effects satisfying this criterion were considered for subsequent LSD tests among means. All

Figure 28. Pictures used in slide-reaction test.

Figure 28. Pictures used in slide-reaction test.

significant effects are reported below. The data from the two Alone-reared animals were informally compared with those from the main groups.

3. Results

(i) Submission and aggression. SUMMARY: Neither submission nor aggression occurred sufficiently often to reveal reliable differences between the groups. However, there was a suggestion of greater fear of the adult male threat picture in the peer-reared group.

There were too few instances of submission to permit meaningful statistical analysis. For example only one mirror-reared animal exhibited any submission, which it did to all five slides in Session 1 and again to the adult male in Session 2. In some contrast, all four peer-reared animals exhibited submission to the adult male threat, but only at the first presentation. Three of these four subjects also briefly submitted to at least one other slide. Interestingly, the five animals who submitted in the presence of the adult male threat slide never submitted longer to any other slide, indicating that the male threat was a relatively strong submission-eliciting picture. Of the two Alone animals, one submitted briefly, once, to the adult male threat, while the other submitted to some other slide categories as well.

Aggression was also extremely rare. Out of the total 100 trials (eight subjects each presented with 5 slides twice, plus 20 trials with the Alone subjects), aggression toward a slide occurred in only 20. These instances were brief, and provided no clear pattern with regard to either rearing condition or stimulus slide category.

(ii) Exploration. SUMMARY: Exploration of the slides was prolific. Pictures of infants elicited more frequent, but not longer, exploration than did pictures of adult females. In Session 2 peer-reared subjects

engaged in more frequent Contact Exploration, and less frequent Noncontact Exploration, producing differences between the two rearing groups in the second session. Peer-reared animals increased overall Contact Exploration time in Session 2, while mirror-reared animals increased looking at infant slides, but decreased the amount of time looking at adult female slides. Generally, the peer-reared group were the more likely to contact the slides. Adult male threats tended to elicit less Contact Exploration than other slides, especially at first presentation. Only peer-reared animals tended to look more at the adult male threat than at the other slides. The two Alone subjects exhibited relatively little exploration of the pictures, but also tended to explore infant slides more than adult female slides. They increased exploration of the adult male threat in Session 2, particularly Noncontact Exploration.

Subjects explored pictures of infants slightly but reliably more frequently than pictures of adult females (rates: 32 and 28 per 5 minutes, respectively), but not for a longer overall duration (18% and 15% respectively). Please note that although each trial lasted 3 minutes, rates are presented using a 5-minute base, to facilitate comparison with home cage results. As might be expected, over all slides Noncontact Exploration occurred more frequently than Contact Exploration, and accounted for more total time.

Three within subjects interaction were significant in the rate analysis: Session X Form, Age X Form, and Expression X Form. None of these three effects reached significance in the percentage analysis. The Expression X Form effect refers to a greater difference between rate of Noncontact and Contact Exploration of fear faces (means 25.6 and 4.8 respectively), compared to neutral faces (23.7 and 6.0). The other two interactions were influenced by the Social Partner variable. Table 10

presents mean rates for Social Partner X Session X Form, $F(1, 6) = 17.8$, $p < .0075$. Whereas exploration rates remained fairly stable across the two sessions in the mirror-reared group, the peer-reared group increased Contact Exploration rate by around 50% in Session 2, and decreased Noncontact Exploration (LSD = 3.2). In Session 2 the differences between the two main groups reached significance, i.e., there were more instances of Contact Exploration in the peer-reared group, but more Noncontact Exploration bouts in the mirror-reared group.

The two groups did not differ in exploration of the adult male threat slides. As can be seen in Table 10, in both groups rate of Contact Exploration of the adult male threat increased from Session 1 to 2, while rate of Noncontact Exploration decreased. This Session X Form effect was reliable. The table also shows rate of exploration of the pictures by the two Alone subjects. It may be noted that their rates of exploration tended to be low, and unchanging over sessions. The exception was an increase in Noncontact Exploration of adult male threat in Session 2.

Social Partner X Age X Form in rate of exploration is presented in Table 11, $F(1, 6) = 12.0$, $p < .025$. Neither main rearing group distinguished between infant and adult female slides in rate of Contact Exploration, but both groups exhibited more frequent bouts of looking at infant slides (LSD = 1.0). Peer-reared animals contacted both types of slide more often than did mirror-reared animals, while the latter group engaged in relatively more looking at infant slides. Peer-reared subjects appeared to look more frequently at the adult male threat than did mirror-reared subjects, but the difference was not significant. Both groups contacted adult male threat pictures less than infant pictures, and slightly less than adult female pictures. However, the picture as regards Noncontact Exploration was less clear.

Table 10 Rates (per 5 minutes) of exploration of pictorial stimuli over two sessions.

Group	Form	Slides of infants and adult females Session 1	Slides of infants and adult females Session 2	Slides of adult male threats Session 1	Slides of adult male threats Session 2
Mirror-reared	Contact	3.4	3.8	1.3	3.5
	Noncontact	24.6	26.0	25.9	20.0
Peer-reared	Contact	5.9	9.0	3.8	5.9
	Noncontact	27.3	20.7	25.8	24.7
Alone-reared	Contact	4.2	2.9	0.0	1.7
	Noncontact	21.1	20.7	17.4	25.5

Table 11. Rates (per 5 minutes) of exploration of different slide categories.

Group	Form	Slide category: Infant	Adult female	Adult male threat
Mirror-reared	Contact	4.0	3.1	2.4
	Noncontact	27.5	23.0	22.9
Peer-reared	Contact	7.7	6.9	4.8
	Noncontact	24.8	23.3	25.3
Alone-reared	Contact	3.6	3.4	0.8
	Noncontact	22.6	19.1	21.4

The tendency toward low rates of exploration is again evident in the two Alone animals' data in Table 11. Like the other subjects, however, they appeared to explore infant slides more frequently than slides of adults. Contact Exploration of the adult male threat was rare in these subjects.

There were no further reliable effects in the analysis of rate of exploration of the slides. When the percentage of time in exploration was considered, some more emerged: Session X Age X Expression, referring to an increase in the amount of time exploring infant pictures and adult female fear pictures in Session 2, but a decrease in exploring adult female neutral pictures; Social Partner X Session X Age X Form, $F(1, 6) = 17.8$, $p < .0075$ (see Table 12), and the highest order interaction, namely Social Partner X Session X Age X Expression X Form, $F(1, 6) = 7.0$, $p < .05$. Table 12 shows that Noncontact Exploration predominated over Contact Exploration. Only peer-reared animals reliably increased time in contact with the slides in Session 2; their Noncontact scores did not vary (LSD = 2.8). Mirror-reared subjects, on the other hand, strongly increased Noncontact Exploration of the infant slides in Session 2, and decreased looking at the adult female slides.

Peer-reared infants exceeded mirror-reared infants in Contact Exploration of adult female slides in both sessions, and infant slides in Session 2 (Table 12). This relationship is reversed for Noncontact Exploration of infant slides in Session 2. In general, the amount of time in exploration of infant slides was not markedly different from that of slides of adult females.

Table 12 also shows the amount of time spent exploring adult male threat pictures. In general, Contact Exploration was diminished compared to that seen with other slides. The same was true regarding Noncontact Exploration in the mirror-reared group, whereas the peer-

Table 12. Percentage of time in exploration of slides over two test sessions.

Group	Form	Infant		Adult female		Adult male threat	
		Session 1	2	Session 1	2	Session 1	2
Mirror-reared	Contact	2.6	3.1	0.9	2.7	0.5	2.3
	Noncontact	12.3	17.8	13.9	10.8	12.0	11.6
Peer-reared	Contact	3.8	9.2	4.1	6.9	2.9	3.8
	Noncontact	12.6	10.2	11.2	10.0	14.6	13.0
Alone-reared	Contact	2.7	0.6	1.2	1.8	0.0	0.7
	Noncontact	12.5	22.0	10.8	9.0	9.3	10.5

reared group tended to look slightly more at the adult male threat than at the other slides.

The two subjects reared alone appeared to spend less time in visual exploration of the slides than did mirror- or peer-reared subjects, especially with adult male threat and adult female slides. However, their score in the second session with infant slides was strikingly high.

Because in several slide test trials (particularly with mirror-reared subjects), Contact Exploration did not occur, only Noncontact Exploration was analyzed with respect to bout length. There were no significant effects.

(iii) Play. SUMMARY: Play directed toward the slides was very rare, and did not differ between the rearing groups.

Play did not occur very often, averaging a rate of 1.0 and 2.1 times per 5 minutes in mirror- and peer-reared groups respectively. Rate of play never differentiated the two groups, and there were no significant main effects. Session X Age X Expression, and Session X Age X Expression X Form reached significance. The latter interaction indicated that Contact Play scores never varied over trials. Only one difference between slides was clear for Noncontact Play: a higher rate toward the neutral adult female than toward the adult female fear picture in Session 1. The same two interactions were significant in the analysis of the percentage of time spent in play. Adult male threat slides also elicited little play, and the behaviour was also uncommon in two Alone subjects.

(iv) Affiliation. SUMMARY: Overall, affiliative responses to the

pictures were more evident in peer-reared than in mirror-reared animals, particularly when fear slides and adult male threat slides were projected. Peer-reared subjects exceeded mirror-reared subjects in Contact Affiliation with infant slides at the first presentation, and with adult female slides in Session 2. Noncontact Affiliation, i.e., lipsmacking, was most prominent in both groups when the adult male threat was first projected. Alone-reared animals virtually never exhibited affiliative responses toward the slides.

Although affiliative responses were quite rare, they revealed differences between the groups. Affiliative behaviours were three times more frequent in the peer-reared group (mirror-reared rate: 0.6 per 5 minutes, Peer-reared: 1.9, $p = .060$). Social Partner X Session X Expression is shown in Table 13, $F(1, 6) = 8.7$, $p < .05$. Mirror-reared subjects increased the rate of affiliation toward both neutral and fear slides in Session 2, but did not respond differentially to the two types of slide (LSD = 0.6). Peer-reared animals, on the other hand, were less frequently affiliative to neutral slides in the second session, but were more affiliative to slides depicting fear. Peer-reared animals were more affiliative to fear slides than were mirror-reared animals, and the same relationship held for neutral slides in Session 1. Peer-reared subjects also appeared more affiliative toward the adult male threats, but this effect was not significant, nor was the decrease in rate of affiliation to the threat in Session 2. In neither group did the threat stimulus elicit strikingly high rates of affiliation. There was a suggestion of relatively more threat-directed Noncontact Affiliation responses in the peer-reared group than in the mirror-reared group ($p = .068$).

Peer-reared animals exhibited affiliation 0.8% of the time, mirror-reared animals 0.3% of the time, $F(1, 6) = 6.8$, $p < .05$. In the Social Partner X Session X Age X Form interaction, $F(1, 6) = 6.4$, $p < .05$ (see

Table 13. Rates (per 5 minutes) of affiliative responses to pictorial stimuli over two test sessions.

Group	Neutral slides		Fear slides		Adult male threat	
	Session		Session		Session	
	1	2	1	2	1	2
Mirror-reared	0.2	1.2	0.2	0.8	1.3	0.0
Peer-reared	1.7	1.3	1.9	2.5	2.6	1.7

Table 14. Percentage of time in affiliation toward pictorial stimuli over two test sessions.

Group	Form	Infant slides		Adult female slides		Adult male threat	
		Session		Session		Session	
		1	2	1	2	1	2
Mirror-reared	Contact	0.1	0.1	0.0	0.3	0.3	0.0
	Noncontact	0.0	0.5	0.1	0.1	0.9	0.0
Peer-reared	Contact	0.3	0.7	0.5	0.3	0.2	0.1
	Noncontact	0.4	0.4	0.3	0.3	0.7	0.5

Table 14), only one difference between sessions was notable, namely an increase in Noncontact Affiliation toward infant slides by mirror-reared subjects. Contact Affiliation toward infant slides was more likely in peer-reared than mirror-reared monkeys, but only significantly so in Session 2, whereas the same was true toward adult female pictures in Session 1. Clearly, both groups devoted relatively large amounts of time to Noncontact Affiliation to the adult male threat, although this disappeared in mirror-reared animals in Session 2. No effects in the analysis of percentage of time spent in affiliation to the adult male threat slides were statistically reliable.

Only two brief instances of affiliation occurred in one of the Alone subjects, to the second infant fear picture. The other Alone animal was not observed to emit any affiliative responses to the pictures.

(v) Overview of slide test results. With the exception of exploration, social behaviours were not strongly elicited by the stimulus slides. For example, submission was infrequent, although it is noteworthy that all four peer-reared animals exhibited it whereas only one mirror-reared subject did so. There was some indication that the adult male threat slides evoked submissive responses more reliably than other slides. Play was also rare during presentation of the slides, and did not differ between the groups.

Other than exploration, affiliative responses were the most useful for revealing effects of the various independent variables. Contact Affiliation with the projected pictures was more typical of peer-reared than mirror-reared animals, suggesting either more sophistication, or possibly more fear in the former group. Also, the peer-reared group

appeared the most sensitive to differing content of the pictures. Thus, their affiliative responses to the neutral and fear slides changed over sessions, whereas those of mirror-reared subjects did not. The peer-reared subjects also emitted a slightly higher rate of lipsmacking (Noncontact Affiliation) to the adult male threat, whereas this reaction did not recur in the mirror-reared group during the second presentation. Interestingly, subjects reared with neither peer- nor mirror-experience virtually never displayed affiliative responses to any slides.

Exploration of the slides revealed several differences between groups and slides. Overall, pictures of infant monkeys attracted more frequent looks than did pictures of adult females, as was predicted. Furthermore, the expressions depicted in the slides were important. For example, Noncontact Exploration was more frequent and Contact Exploration less frequent when fear faces, rather than neutral expressions, were projected. The latter behaviour was more common in the peer-reared group than in the mirror-reared group, especially in the second session, whereas mirror-reared subjects were the most frequent lookers at slides of infants.

Both groups of subjects were reluctant to contact the adult male threat slides, especially in Session 1. In Session 2 Contact Exploration increased, at the expense of simple looking. One interesting difference between the groups was that only the peer-reared group gave an indication of spending more time in visual exploration of the adult male threat than the other categories of slides.

Finally, exploration of the slides tended to be least evident in the two Alone subjects. However, like the other subjects, they appeared to pay more attention to pictures of infants than pictures of adult females, and they infrequently contacted the adult male threat slides.

A few preliminary integrative statements are possible here. Firstly, overt social behaviours were not conspicuous in the responses of the stumptail infants to projected pictures of conspecifics, although some submissive and affiliative gestures were observed. Exploration of the slides was prominent, and revealed differences between rearing conditions and the various categories of slides. Secondly, on the whole, the peer-reared group appeared more 'tuned' to the contents of the slides. Thus they were more likely to look longer and lipsmack to the adult male threat, and to initiate Contact Exploration and Affiliation with other slides, than were mirror-reared animals. The fact that mirror-reared animals exceeded their peer-reared counterparts in rate of looking at the infant slides is not easily interpretable, but might indicate apprehension or caution in the former group. There was also other evidence of responsiveness to the different social-emotional contents of the pictures. For example, pictures of infants evoked more frequent visual exploration than did pictures of adult femals, and pictures of an adult male threatening were not often contacted. Finally, subjects reared entirely alone exhibited diminished responsiveness to the slides, particularly with regard to exploration and affiliation.

The following chapter reports on other tests carried out on the subjects, including their reactions to a moving film of a conspecific, and to their own normal and altered mirror images.

CHAPTER EIGHT. TESTS OF MIRROR IMAGE REACTIONS AND SELF-RECOGNITION

8.1 Reactions to a Film of a Conspecific and to MIS

1. Introduction. One of the experiments reported in this chapter involved presenting the subjects with a moving film of a conspecific. Klüver (1933) appears to have been the first to publish an account of the reactions of monkeys to motion pictures. The account was very brief, and was mainly a suggestion that the technique could be useful in analyzing social mechanisms in primates. Almost thirty years later Butler (1961) demonstrated that rhesus monkeys preferred to look at moving pictures of conspecifics than at static projected pictures, and that they preferred in-focus films. Sackett (1966) used moving films as well as slides in the rhesus 'picture isolate' studies, and reported that behaviours exhibited during the film sessions paralleled those in the slide sessions (see Section 7.2). Convincing evidence that monkeys are responsive to the behavioural or affective content of moving pictures comes from Miller (1967). Miller's studies revealed that socially-reared rhesus monkeys could make use of social cues, i.e., televised images of a conspecific's facial expressions, to regulate their own responses on a lever to avoid an electric shock. Isolates could not use the transmitted social cues in this way. Humphrey and Keeble (1976) found that rhesus monkeys' interest in a television picture of a conspecific increased when the picture changed to a different individual engaging in a different activity. The relative contributions of the change of the target animal and the change in activity were not determined.

To date the best documentation of social responsiveness to moving pictures of conspecifics is by Plimpton et al. (1981). Their subjects were juvenile bonnet macaques (M. radiata) living in groups with peers and adult females. The stimuli were colour videotapes of (a) a passive

adult female, (b) a passive adult male, (c) a threatening adult male. Measures included social behaviours toward other group members, and approaching and lipsmacking toward the picture on the monitor. Approaches were most frequent to the passive adult female, and least frequent to the adult male threat. Similar results were obtained with duration as the measure. The reverse relationship was evident with regard to lipsmack, a form of appeasement.

The present study provided the opportunity to assess the responsiveness of stumptail macaques to a moving film of a conspecific, and to examine the potential of the technique for revealing differences in animals with varied social histories. To the author's knowledge there are no published accounts of similar work.

Responses to mirror image stimulation were also assessed at this stage of the study. Gallup and McClure (1968) found that adult isolation-reared rhesus monkeys looked longer at their own reflections than at a true conspecific, whereas the reverse preference was present in socially-reared monkeys. This difference was explained in terms of the animals preferring different levels of stimulus predictability or complexity (see also Sackett, 1973b). The present experiment represents the first attempt to discover differential attraction toward MIS in stumptail macaques reared under different conditions. In addition, this experiment is unique in (a) employing infant subjects, and (b) systematically comparing the social stimulus value of a mirror in grossly mirror-experienced and in mirror-naive monkeys.

On the basis of the known interest in mirrors shown by mirror-naive monkeys (see Section 1.9), it was expected that animals with the least mirror-experience, i.e., Alone and Peer Only animals, would be the most responsive to MIS, but that the former pair of animals would show the most interest (Gallup and McClure, 1968). Also, the 'super-

stimulus' aspect of MIS (Gallup, 1971, 1975) leads to the prediction of more social responses toward a mirror than toward a film, at least in peer-reared animals. Since the film nevertheless constitutes an unpredictable stimulus, peer-reared animals might be expected to exhibit greater interest in it than would mirror-reared animals. On the other hand, the novelty of a social stimulus which did not merely imitate might enhance film-directed attention in Mirror-Only animals.

2. Interlude. Two days after the slide reaction tests described in the previous chapter, the subjects were given a film-mirror choice test. This test consisted of two trials, separated by 30-40 minutes, each presenting the subject with the choice of entering a choice chamber which contained a mirror at the end, or a chamber which contained a projected moving, colour film of a conspecific. The procedure was very similar to that used in the picture-choice tests (Section 7.3.2). Due to considerations of space, the film-mirror choice test will not be considered further. It should be noted that for the two Alone and the two Peer-Only subjects, the two film-mirror choice trials constituted their first introduction to MIS; a possible maximum total exposure of 14 minutes, and in reality much less than this. Two days later, the film-mirror-reaction test was conducted, as described below.

3. Methods.

(i) Procedure. As far as possible, the setting, procedure, and data collection procedures in the film-mirror-reaction test duplicated those in the slide-reaction test (Section 7.4). The only differences were those minor modifications necessary for presenting the stimuli. Each subject received four 3-minute trials, two with a film of an infant stumptail, and two with a mirror. The stimulus to be presented first was decided randomly for each subject, thereafter consecutive trials involved the alternative stimulus. The film showed a 7-month old

stumptail infant in a transparent Perspex cage with dimensions identical to those of the subjects' home cages. The action consisted mainly of the infant walking and manipulating or holding its diaper, and sometimes sucking its thumb. There was no sound-track. The background of the film was blue. When projected, the image of the infant monkey was approximately life-sized. The film lasted 4 minutes and 30 seconds, so there was some overlap in the material projected in the two film trials. The mirror measured 22 X 25 cm. The paper screen onto which the film was projected was removed immediately before the mirror was positioned for the start of a mirror trial (see Figure 23).

(ii) Analysis. Since the Peer-Mirror animals were mirror-sophisticated, it was decided to include the two between subjects factors in the anovas: Social Partner and Additional Experience. The within subjects variables were Stimulus (Film or Mirror), Presentation (1 or 2), and, where applicable, Form (Contact or Noncontact). As before, alpha was set at .05, with the subsequent LSD tests only considered with significant anova effects. All such effects are reported, but with only the most important F values presented in the text; others being available in Appendix 7.

4. Results.

(i) Submission and aggression. SUMMARY: Submission and aggression occurred too rarely to permit meaningful statistical analysis. Overall, the mirror seemed to elicit more of these behaviours than did the film, with PO pair appearing more antagonistic than PM pair. One Alone animal exhibited fairly frequent submission and aggression, the latter particularly toward the mirror.

Neither stimulus elicited much submission or aggression, and the data

from these behaviours were not formally analyzed. Only one mirror-reared animal, from MX pair, briefly submitted toward the film, while no peer-reared animals did. No mirror-reared animals submitted to the mirror, while the two PO animals each submitted once to the mirror. One of the two Alone subjects exhibited some submissive responses in all four trials, while the other only submitted on one occasion, to the mirror.

Only one mirror-reared and one peer-reared animal displayed aggression toward the film, both instances lasting less than one second. All four mirror-reared animals exhibited at least one bout of aggression toward the mirror, whereas from the peer-reared group only PO animals did. The Alone animal who showed most submission to the stimuli also exhibited aggression on all four trials. Aggression to the mirror was especially prominent in this animal, accounting for over 20% of the duration of both mirror trials. In contrast, this animal's aggression to the film did not exceed 1% of the trial. The second Alone subject exhibited no stimulus-directed aggression.

(ii) Exploration. SUMMARY: Mirror-reared animals exceeded peer-reared animals in exploration, mainly due to their greater interest in the film. Animals reared only with a mirror explored the film more than did the other subjects, and animals reared only with a peer were the only ones to show significantly more exploration of the mirror than the film. Overall, the mirror elicited more frequent exploratory responses than the film, and there was more Contact Exploration of the stimuli on the second presentation. Subjects reared entirely alone did not explore the film as much as did mirror-reared animals.

Mirror-reared animals engaged in a 30% higher rate of exploring the stimuli than did peer-reared animals (means 48.8 and 36.9 respectively),

$F(1, 4) = 10.5$, $p < .05$, and 30% more time, 24% versus 18%, $F(1, 4) = 20.4$, $p < .025$. Overall, the mirror commanded more frequent exploration than the film, and as usual, Noncontact Exploration was much more common than Contact Exploration. These general trends also held for the two Alone subjects. There was more exploration during the second presentation of the stimuli, and Presentation X Form in the rate analysis indicated that this was mainly due to increases in Contact Exploration.

On both measures, Social Partner X Stimulus was significant, and Additional Experience X Stimulus reached significance with regard to the percentage of time spent in exploration. However, Social Partner X Additional Experience X Stimulus was also significant on both measures, and these effects are illustrated in Figure 29; rate: $F(1, 4) = 10.2$, $p < .05$, percentage: $F(1, 4) = 21.2$, $p < .025$. Both mirror-reared pairs exhibited a higher rate of exploration of the film than did the two peer-reared pairs (a). The two Alone animals were also considerably below the mirror-reared group in this respect. PO animals explored the mirror more frequently than the film. Neither the two mirror-reared pairs, nor the two peer-reared pairs differed from each other in the rate of exploring the stimuli. There were no clear pair differences in the rate of mirror-exploration (but note the relatively low Alone score).

Considering the percentage of time spent exploring the stimuli (Figure 29b), MO animals clearly exceeded all other pairs in exploring the film, e.g., 32% of time versus less than 15% of time in the two peer-reared pairs (LSD = 6.0). Furthermore, MO pair's film exploration score was reliably greater than its mirror exploration score, while MX pair did not differentially explore the two stimuli. Of the two peer-reared pairs, only the PO pair differentially explored the film and mirror, the latter stimulus eliciting over 50% more exploration. Again

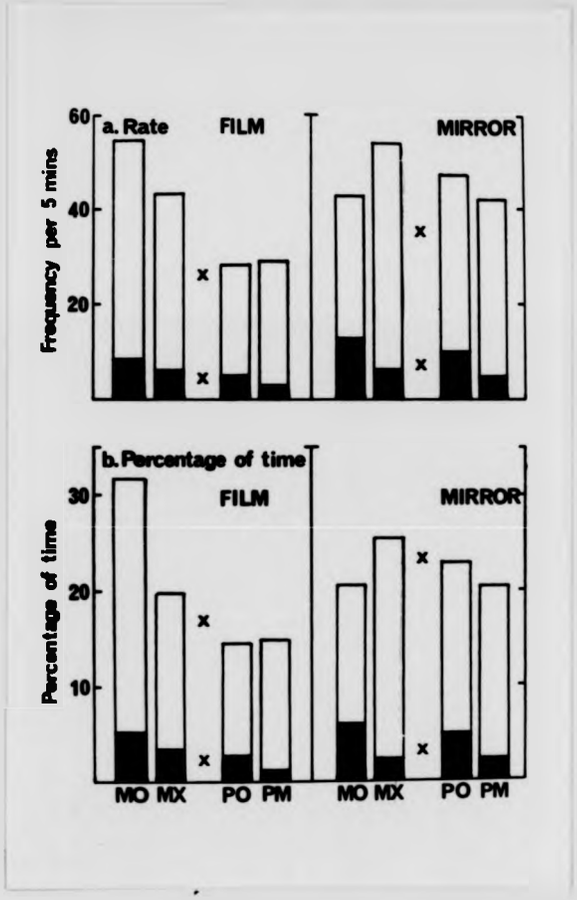

Figure 29. Exploration of two types of social stimulus. Dark bars: Contact; light bars: Noncontact; x: Alone-reared means.

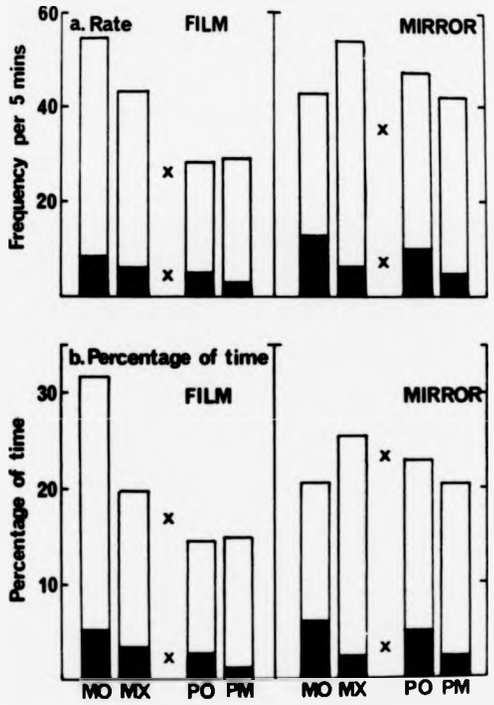

Figure 29. Exploration of two types of social stimulus. Dark bars: Contact; light bars: Noncontact; x: Alone-reared means.

there were no differences among any of the pairs in mirror exploration. The two Alone animals did not differ much from other animals in the amount of time spent exploring the stimuli, and like other pairs, their film exploration score was low compared to that of MO pair.

There were not sufficient data to analyze length of Contact Exploration bouts, and the Noncontact analysis revealed no significant effects.

(iii) Play. SUMMARY: Play was 5 times more frequent toward the mirror than toward the film. Even so, it was rare, and revealed no differences among the animals.

The scant play data did not reveal any differences among the pairs of subjects. Of the mirror-reared animals, only MO pair exhibited any play; one to both stimuli, the other only briefly to the mirror. Of the peer-reared animals, only PO pair exhibited any play; one to both stimuli, the other occasionally only to the mirror. The mirror elicited 5 times more instances of play than did the film, and a non-significant trend in this direction was also apparent in the percentage of time data. Alone-reared subjects did not exhibit play during any of the test trials.

(iv) Affiliation. SUMMARY: Affiliation was clearly more prominent toward the mirror than the film. PO and MX animals appeared particularly affiliative toward the mirror. Alone-reared subjects almost never displayed affiliation toward the stimuli.

Analysis of the amount of time spent in affiliation with the stimuli revealed one reliable effect: affiliation toward the mirror was over 7 times more common than toward the film, 4.9% and 0.7% respectively.

Table 15. Rates (per 5 minutes) of affiliative responses toward a film and a mirror over two presentations.

Pair	Film		Mirror	
	1	2	1	2
Mirror-Only	2.1	0.0	4.6	0.0
Mirror-Perspex	0.0	1.7	12.6	8.3
Peer-Only	0.0	0.0	14.3	6.8
Peer-Mirror	0.0	0.0	4.2	7.2
Alone	0.0	0.0	1.8	2.5

Rate of affiliative responses to the mirror was also 15 times higher than that to the film.

Two notable interactions in the rate analysis were Social Partner X Additional Experience X Presentation X Form ($p = .054$), and the highest order interaction, i.e., the above effect with Stimulus included ($p = .055$). Table 15 presents the means, omitting the Form variable. Infrequent affiliation toward the film is apparent in all pairs of subjects. The first presentation of the mirror was associated with considerably more affiliative responses especially in PO and MX animals. The second mirror presentation resulted in lower affiliation scores in all but PM pair. Alone subjects were the least affiliative.

(v) Overview of film-mirror-reaction test results. Without question, the mirror elicited more behaviour from the subjects than did the film of an agemate. This was apparently true for agonistic behaviours, and definitely true for affiliation, play, and rate of exploratory responses, indicating the relatively greater social stimulus potential of MIS.

In the previous chapter it was found that peer-reared animals were more responsive to various slides of conspecifics than were mirror-reared animals. The present chapter's results indicate that this greater responsivity does not generalize to a moving film of a conspecific. In fact it was mirror-reared animals, especially those whose entire social experience consisted of MIS (MO pair) who were most attentive to the film. Possible reasons for these differences are considered in the Discussion (Chapter 9).

Given the somewhat contrasting patterns of results obtained in the slide reaction tests (Chapter 7) and the present test, it is of interest to compare the absolute values of the response measures to the various stimuli. This comparison is attempted with the aid of Table 16, which

contains means for the two most discriminating behaviours, namely exploration and affiliation. Rate and percentage of time values are given for the first 3-minute presentation of the stimuli. Of the slide categories, only the infant ones are considered, since these are the most appropriate to compare with MIS and the film in terms of the age of the stimulus animal. By comparing columns 3 and 4, it can be confirmed that in the two main groups of subjects, the first presentation of the mirror produced more exploration and affiliation than did the first presentation of the film. This trend is also apparent in the data from the two Alone animals, although they never exhibited Contact Affiliation. In general, these two behaviours were also more evident in mirror tests than in slide tests, further indicating the relatively salient social overtones of the mirror image for the animals.

It is more difficult to detect any clear pattern by comparing responses to the film with responses to the slides. Considering the percentage of time in exploration, with the film there is a prevalence of Noncontact Exploration. This pattern also occurs in the mirror-reared group's exploration rate scores, but rates in the peer-reared group were always lower to the film than to the slides. Turning to affiliation, while this occurred more to the film in the mirror-reared group, the slides elicited more affiliation in the peer-reared group. Of course the Alone subjects never displayed affiliation to either static or moving pictures.

The complexity of the results described above caution against making wide generalizations about the relative ability of various types of social stimulus to evoke social behaviours from monkeys. The prior social experiences of the animals are important. In brief, in the present experiment, mirror-reared subjects were highly responsive to a moving film, whereas peer-reared subjects appeared more responsive to slides. Interpretation of the results is attempted in the next

Table 16. Exploration and affiliation under four stimulus conditions.

EXPLORATION

Group	Parameter	Form	STIMULUS			
			Infant explore slide	Infant fear slide	Infant film	MIS
Mirror-reared	Rate	Contact	6.3	3.5	2.9	7.7
		Noncontact	24.5	29.7	37.9	41.5
	Percentage of time	Contact	3.7	1.4	1.8	3.3
		Noncontact	11.9	12.7	18.4	19.5
Peer-reared	Rate	Contact	6.8	5.5	1.7	5.0
		Noncontact	29.8	27.6	25.1	25.4
	Percentage of time	Contact	4.0	3.7	1.3	2.7
		Noncontact	12.5	12.8	13.4	16.5
Alone-reared	Rate	Contact	5.1	6.2	6.5	7.9
		Noncontact	17.8	25.7	20.8	30.8
	Percentage of time	Contact	2.3	3.1	3.5	7.0
		Noncontact	10.9	14.2	12.8	19.1

AFFILIATION

Mirror-reared	Rate	Contact	0.4	0.0	0.5	3.9
		Noncontact	0.0	0.0	0.5	4.8
	Percentage of time	Contact	0.2	0.0	0.6	3.6
		Noncontact	0.0	0.0	1.5	1.9
Peer-reared	Rate	Contact	0.0	1.3	0.0	2.1
		Noncontact	0.9	1.3	0.0	7.2
	Percentage of time	Contact	0.0	0.6	0.0	2.7
		Noncontact	0.3	0.6	0.0	4.3
Alone-reared	Rate	Contact	0.0	0.0	0.0	0.0
		Noncontact	0.0	0.0	0.0	1.8
	Percentage of time	Contact	0.0	0.0	0.0	0.0
		Noncontact	0.0	0.0	0.0	0.7

chapter, but some preliminary statements are offered here. As expected, animals raised only with a peer (PO pair) were highly exploratory toward the mirror. Furthermore, it was only these animals of the peer-reared group who exhibited any play or aggression toward the mirror, and they produced the highest mirror-affiliation score of all. These results point toward high responsiveness to a mirror in mirror-naive, socially-reared subjects, and suggest some degree of habituation to the mirror in mirror-sophisticated subjects. The results obtained from the two Alone subjects indicate that responsiveness to social stimuli may be impaired by a lack of some form of social input in early life. Although Alone subjects were slightly more responsive to the mirror than to the film, they never played and almost never exhibited affiliative responses. One of these two subjects was extremely aggressive toward the mirror, while the other showed no aggression at all, suggesting wide variability in the reactions of these subjects.

The next experiment examined the reactions of the subjects to longer exposures to MIS in a home cage environment.

8.2 Reaction to MIS in a Home Cage Environment

1. Introduction. The experiment reported in this section comprised the first formal test of whether any of the subjects had learned to recognize themselves in the mirror. In order to test this objectively, a dye test based on that used by Gallup (1970, see Section 1.4) was employed. It was also of interest whether mirror-sophisticated and mirror-naive subjects would respond differentially toward the mirror in terms of social responses. In the film-mirror-reaction test (Section 8.1) there were indications that mirror-naive, socially sophisticated monkeys were highly responsive to MIS in comparison to

chapter, but some preliminary statements are offered here. As expected, animals raised only with a peer (PO pair) were highly exploratory toward the mirror. Furthermore, it was only these animals of the peer-reared group who exhibited any play or aggression toward the mirror, and they produced the highest mirror-affiliation score of all. These results point toward high responsiveness to a mirror in mirror-naive, socially-reared subjects, and suggest some degree of habituation to the mirror in mirror-sophisticated subjects. The results obtained from the two Alone subjects indicate that responsiveness to social stimuli may be impaired by a lack of some form of social input in early life. Although Alone subjects were slightly more responsive to the mirror than to the film, they never played and almost never exhibited affiliative responses. One of these two subjects was extremely aggressive toward the mirror, while the other showed no aggression at all, suggesting wide variability in the reactions of these subjects.

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other monkeys. By testing the animals in a more familiar setting and over a longer time, the generality of this finding could be determined.

2. Methods.

(i) Procedure. On the first Monday following the film-mirror-reaction test, the home cage mirror-reaction test commenced. To begin the test, the experimenter prepared the DTU for use behind the screen in the nursery, since all observations in this test were made from behind the screen. The experimenter then walked to the subject's cage, removed the subject and its diaper from the home cage, and placed them into a cage further along the row. This cage was identical to the Weekday cages in which the mirror-reared animals were housed, i.e., it was a new home cage fitted with two mirrors on two of the cage sides, forming a mirror right-angle. Thus for the two Peer-Only and the two Alone subjects, this procedure provided the first introduction to MIS inside a home cage, and to the triple mirror image effect. Of course the mirror-reared and Peer-Mirror animals were used to this arrangement.

After placing the subject into the test cage, the experimenter took up position behind the observation screen, and proceeded to record the subject's behaviour for a period of 5 minutes. The behaviour categories employed were those previously utilized during home cage tests with mirror-reared animals. Observations were made during the periods 0-5, 15-20, 30-35, and 45-50 minutes after the subject had been placed in the test cage. During the non-observation intervals, the procedure was repeated with the second animal for peer-reared and MX animals. Otherwise, the experimenter left the room between observation blocks, returning in time to begin the next observation. Observations were carried out for five consecutive days, during which

time the subject remained in the test cage day and night, except for two occasions described below. On Day 4, immediately prior to the first observation, the subject was taken from the test cage and carried to a nearby room. There the experimenter held the subject for approximately 3 minutes, occasionally wiping its head with a damp cloth, and then returned it to the test cage and began the first observation. This procedure was aimed at revealing any effects on mirror image reactions of brief removal from the mirror cage and being treated in a fashion similar to that involved in applying dye to the subject's head. On Day 5, the subject was again removed from the cage before testing, and taken to the same room as on the previous day. An assistant helped the experimenter to apply a water-based red dye (Rhodamine B) to the subject's head, using a cloth. The dye is the same as that originally chosen by Gallup (1970) for its odourless and nonirritant qualities. The mark was a band of red across the subject's head, just above the eyes (Figure 30). As soon as the mark was dry, the subject was returned to the test cage and the first observation commenced.

(ii) Analysis. A record of mirror-reactions was obtained for each subject, consisting of four 5-minute observations per day for 5 days. Where possible, analyses of variance were carried out on mirror-directed behaviour data. Social Partner and Additional Experience were the between subjects factors, and Days (1-5), Blocks (1-4), and Form (contact or noncontact) were within subject variables. LSD tests among means were reserved for anova effects which occurred at $p < .05$. All such effects are reported below, but only F values for effects involving between subjects variables are presented in the text, others being available in Appendix 8.

Figure 30. A monkey before (top) and after (bottom) being marked for a self-recognition test.

Figure 30. A monkey before (top) and after (bottom) being marked for a self-recognition test.

3. Results. None of the subjects used the mirror to guide self-directed behaviours, or made use of the reflections to investigate the marks on their heads, suggesting the absence of self-recognition even after more than 9 months, or approximately 3,500 hours of the mirror-rearing schedules. Mirror-directed responses over the five days are described below.

(i) Submission and aggression. SUMMARY: Submission was almost never observed, except in Alone-reared subjects. Aggression was generally most common on Day 1, and again in the first 5-minute block following the marking of the monkeys on Day 5. MO animals showed no aggression on Day 5, while PM showed overall least aggression. Alone-reared subjects were very aggressive toward the image on the first day of mirror housing.

Submission occurred too infrequently to permit statistical analysis. It was never observed in mirror-reared animals, and only one peer-reared animal exhibited a submissive gesture to the mirror, on Day 5. Both Alone-reared subjects exhibited brief submission to the mirror on each of three days.

Mirror-directed aggression was more common than submission, but still infrequent. Days effects in the rate and percentage analyses indicated that aggression was most pronounced on Days 1 and 5, i.e., on initial introduction to the mirror cage, and then when the subject's head was marked. The Social Partner X Additional Experience X Days interactions were highly significant, rate: $F(4, 16) = 9.0$, percentage: $F(4, 16) = 9.2$, both $p < .00075$. These showed that aggression peaked on Days 1 and 5 in MX, PO and PM pairs, with the latter pair's increases being smaller, and one also occurring on Day 3. MO animals deviated

from this pattern, exhibiting no aggression on one Day, and most on Day 3. Overall, PM pairs exhibited the least frequent aggression of the four pairs, $F(1, 4) = 8.8$, $p < .05$. The one remaining effect in the rate analysis was Social Partner X Days X Block, $F(12, 48) = 2.4$, $p < .025$. The features most worth noting were that the mirror-reared group's aggression rate (in reality that of MX pair) on Day 5 was higher than in any block on the previous day. Peer-reared animals exhibited relatively high levels of aggression on Day 1, but considerably more on Day 5 Block 1.

Also significant in the percentage analysis were Social Partner X Days, Days X Blocks, and Social Partner X Days X Blocks, $F(12, 48) = 2.9$, $p < .005$. In mirror-reared animals, the three blocks which produced the most aggression were, in descending order: Day 1 Block 4, Day 3 Block 2, Day 5 Block 1. In peer-reared subjects the order was Day 5 Block 1, Day 1 Block 1, and Day 1 Block 3 tied with Day 5 Block 4.

On only one occasion did an aggressive response toward the mirror last longer than 2 seconds. Because of the general infrequency of aggression, and the brevity of aggressive episodes, bout length was not analyzed. In some contrast to the main rearing groups, however, outbursts of mirror-directed aggression did sometimes exceed 2 seconds in Alone animals, and aggression in these subjects was generally more evident than in the other subjects, especially on Day 1. One of these two subjects exhibited no aggression on Day 5.

(ii) Exploration. SUMMARY: Peer-reared animals initially explored the mirror more than did mirror-reared animals, but this difference disappeared by Day 2. Looking at the mirror without contacting it was particularly characteristic of peer-reared monkeys. Mirror-

exploration tended to decrease over days, with some evidence of a recovery on the day of the dye test. In the mirror-reared group, this recovery was only shown by MX pair, and of the peer-reared group only PM animals increased mirror-exploration time on Day 5 over the Day 4 level. Overall, animals reared with only one social partner (MO and PO pairs) explored the mirror more than did additionally experienced (MX and PM) pairs. The 5-minute block associated with most mirror- exploration was that immediately following the animals being marked with dye. Surprisingly, this effect, and mirror-exploration in general, seemed most pronounced in the two subjects reared alone.

Those animals reared with no additional Weekend social experience, i.e., MO and PO animals explored the mirror image more frequently than did MX and PM animals, with rates of 28.2 and 19.7 per 5 minutes, respectively, $F(1, 4) = 12.7$, $p < .025$. MO and PO pairs also explored the reflection for more total time than did the additionally experienced pairs, 18% versus 10%, $F(1, 4) = 11.8$, $p < .05$. In both analyses Days, and Social Partner X Days were reliable, as is illustrated in Figure 31. Peer-reared animals explored the mirror more frequently, and for longer than did mirror-reared animals on Day 1 (23% and 11%, respectively, LSD = 5.4). Thereafter, the two groups did not differ in exploration, principally due to a decline in the peer-reared group on Day 2. Both groups exhibited gradual declines between days 2 and 4. On day 5, the rate and amount of time spent in exploring the mirror image recovered to the original levels in the mirror-reared group. However, Day 5 exploration in peer-reared animals did not increase, and remained well below that observed on Day 1. Social Partner X Days rate: $F(4, 16) = 3.9$, $p < .025$; percentage: $F(4, 16) = 5.0$, $p < .01$.

Figure 31 also shows that the two Alone-reared monkeys initially explored the mirror as much as did peer-reared animals. Over the next three days exploration decreased by more than half, but recovered on the day of the dye test, e.g., from less than 10% of time on Day 4 to almost 25% on Day 5. Compared to the levels of the main rearing groups, the amount of time in exploration of the mirror was generally high in the Alone monkeys.

Additional Experience X Days in the percentage analysis, $F(4, 16) = 5.0$, $p < .01$, showed that those animals with no Weekend social experience (MO and PO) generally spent 50% more time exploring the mirror than did animals given additional experience (MX and PM), the difference being significant on Days 2, 3, and 4 (Figure 32). It is a striking feature of the data that in 'additional experience' animals mirror-exploration more than doubled on Day 5 from the previous day's level, catching up on the amount exhibited by the 'no additional experience' animals, whose Day 5 score was similar to those on the previous two days.

Both rate and percentage of time analyses confirmed the predominance of Noncontact Exploration over Contact Exploration. Social Partner X Form was reliable in the rate analysis, $F(1, 4) = 28.5$, $p < .0075$, and almost so in the percentage analysis ($p = .0502$). Whereas Contact Exploration occurred equally in both groups, and was always less common than Noncontact Exploration, the latter form was relatively more evident in the peer-reared group.

Blocks X Form effects indicated a tendency for Noncontact Exploration to predominate over the contact form in all blocks, but especially in the first. One other interaction was reliable, namely Days X Blocks, the most notable aspect being that mirror-exploration in the first block of Day 5 accounted for more time (27%) than in any

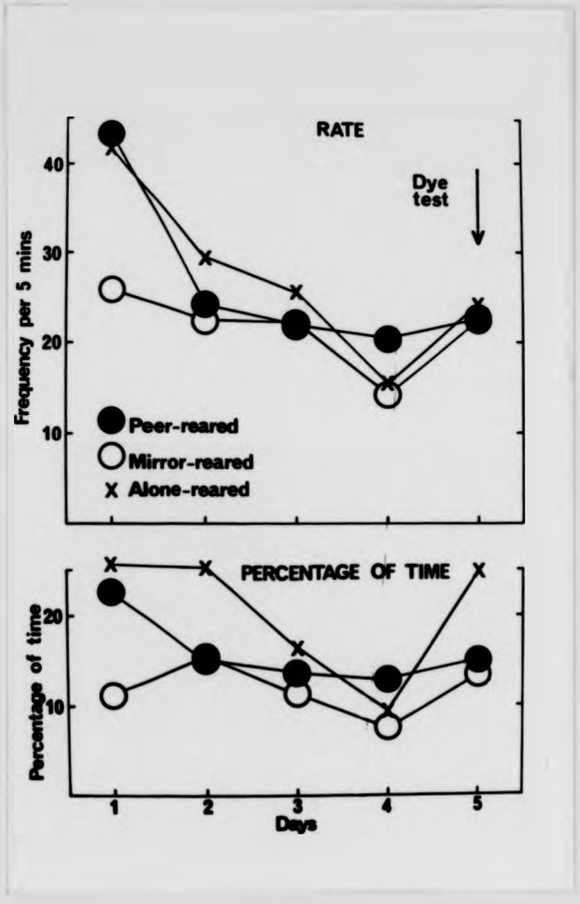


Figure 31. Exploration of own mirror image over five days.

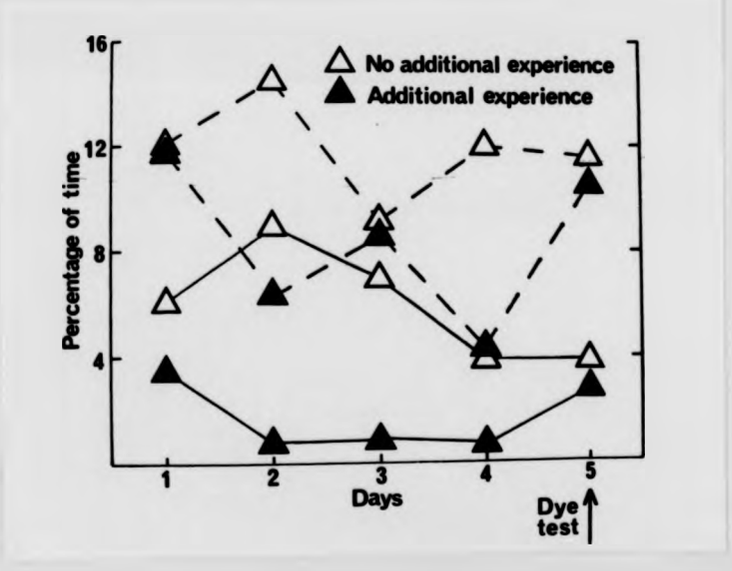
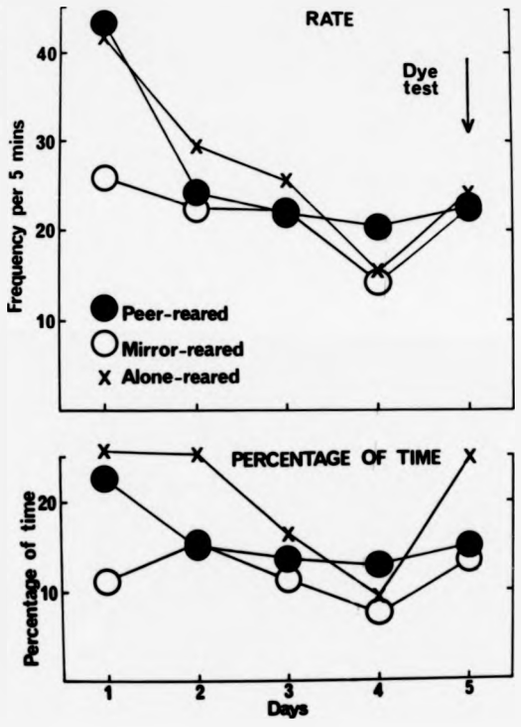


Figure 32. Amount of time in mirror exploration in 'additional experience' and 'no additional experience' groups. Solid line: Contact; broken line: Noncontact.



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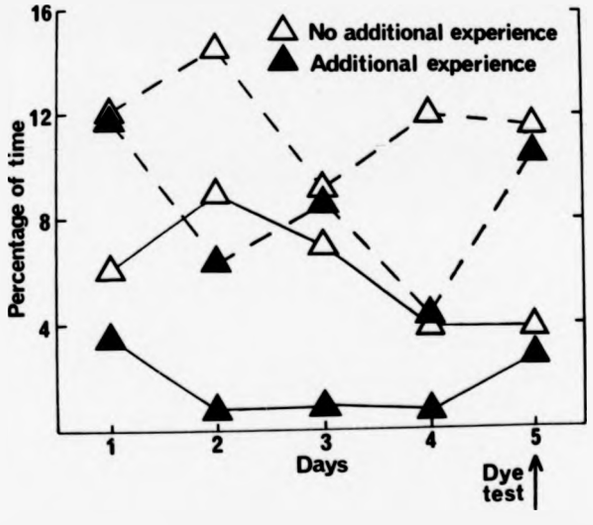


Figure 32. Amount of time in mirror exploration in 'additional experience' and 'no additional experience' groups. Solid line: Contact; broken line: Noncontact.

other block, the nearest falling just below 20%.

Since Contact Exploration did not occur in a number of blocks, only the duration of Noncontact Exploration bouts were analyzed. There were no differences between groups. One effect emerged, namely Days X Blocks. The clearest feature in this interaction was that the longest looks at the reflection occurred on Day 5 Block 1, i.e., when the animals first saw the changed appearance of the image in the mirror. Overall mean bout length was 1.6 seconds, but in this critical block it was 2.1 seconds. Interestingly, the corresponding durations in the Alone-reared subjects were higher: 2.2 and 3.3 seconds.

(iii) Play. SUMMARY: Animals that had been reared with only one type of social partner, i.e., MO and PO animals, engaged in more mirror-play than did animals whose rearing conditions involved an additional partner at weekends (MX and PM pairs). The PO pair clearly exceeded PM animals in Contact Play, and generally resembled MO animals in mirror-directed play, although performing less Noncontact Play. The MX pair played least of all with the mirror. Surprisingly, the two Alone-reared infants exhibited most mirror-play of all.

Significant Additional Experience main effects indicated that MO and PO animals played with the mirror image over twice as frequently, $F(1, 4) = 36.2$, $p = .005$, and for over twice as much time, $F(1, 4) = 16.8$, $p < .025$, as did MX and PM animals. Rates averaged 12.4 and 4.6 respectively, and percentages were 7.3 and 2.9. Play was most frequent in Blocks 3 and 4, and both analyses produced significant Social Partner X Additional Experience X Blocks interactions. Within the mirror-reared group, MX pair always played infrequently, whereas MO pair played at over twice the rate in Block 4 as in Block 1. Within the peer-reared

group, rate of play was consistent across blocks in PO pair. It tended to be less frequent in PM animals, but was at a level similar to that of PO pair in Block 4, $F(3, 12) = 5.9$, $p = .01$. An almost identical pattern was evident in the percentage analysis, $F(3, 12) = 4.6$, $p < .025$. Block 4 also had the highest play scores in the two Alone subjects, and Block 1 least.

In both analyses the Form main effect indicated that Noncontact Play was over twice as common as Contact Play. Additional Experience X Form, $F(1, 4) = 10.0$, $p < .05$, indicated that while MO and PO pairs exceeded MX and PM pairs in rate of engaging in both forms of play, the biggest differences were in Noncontact Play.

The divergence in play patterns within the two main rearing groups can be seen clearly in Figure 33, illustrating the Social Partner X Additional Experience X Form interactions in rate of play, $F(1, 4) = 21.2$, $p < .025$, and percentage of time in play, $F(1, 4) = 16.5$, $p < .025$. Looking first at the rate measure, although play involving no physical contact with the mirror surface was almost twice as frequent as Contact Play in MX pair, the difference was not significant (LSD = 2.0). In the considerably more playful MO pair, the corresponding difference is substantial. Both peer-reared pairs also exhibited a higher rate of Noncontact Play than Contact Play. The differences between MX pair's play scores and those of the other three pairs were all significant except for PM pair's Contact Play scores. Percentage of time gives a similar picture, but with MO pair also exceeding both peer-reared pairs in Noncontact Play with the mirror. A surprising outcome was the relatively high levels of mirror-play in the two Alone subjects, with Contact Play averaging over 3% of time, and Noncontact Play over 6% (Figure 33).

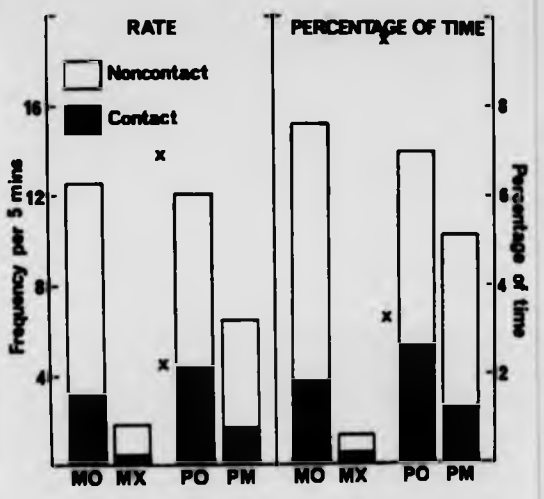


Figure 33.
Rate and percentage of time in mirror-directed play.
x: Alone-reared means.

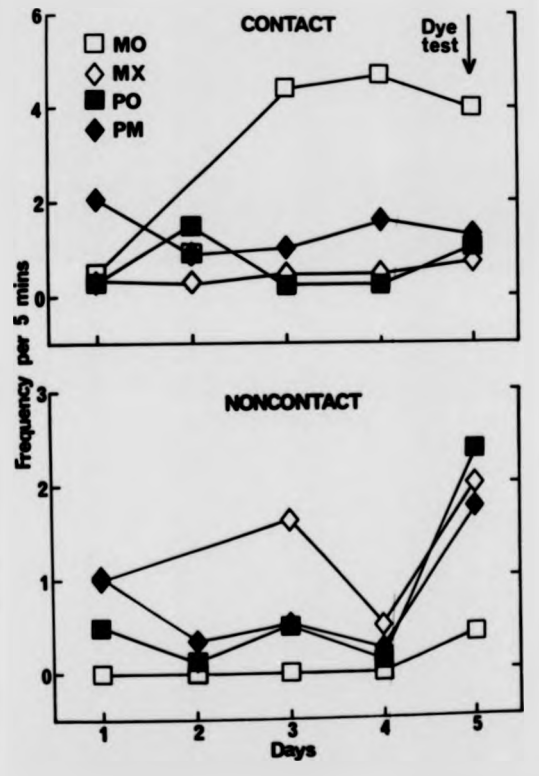
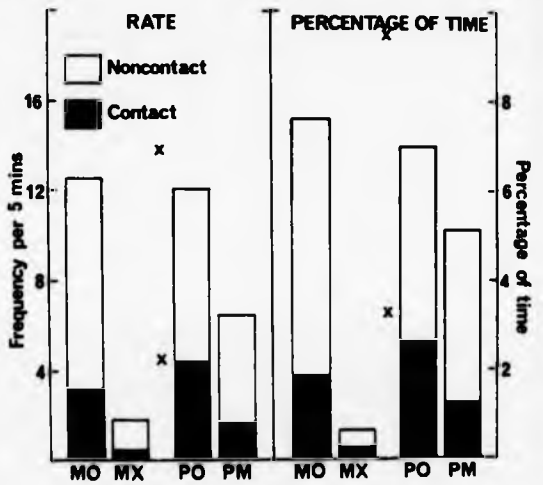


Figure 34.
Rate of mirror-directed affiliative responses over five days.



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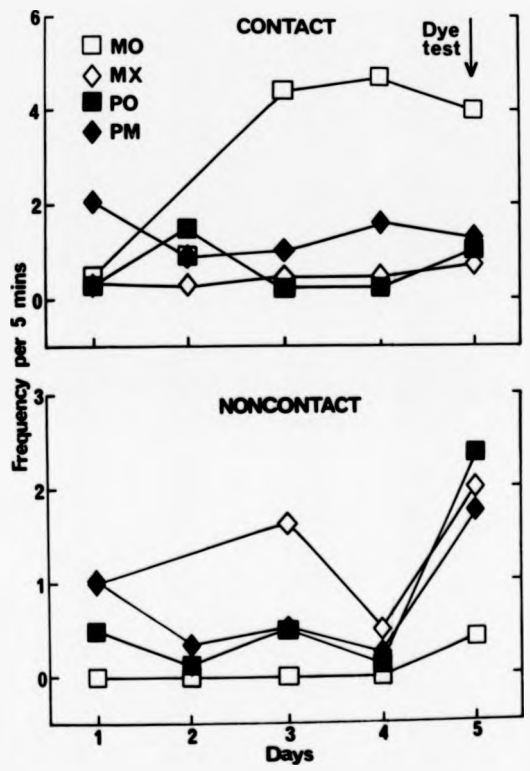


Figure 34.
Rate of mirror-directed affiliative responses over five days.

There were no other significant effects in the analyses of mirror-directed play. Play bout lengths were analyzed after averaging the data across days and blocks, but there were no significant differences. Bouts of play averaged 1.7 seconds in MO, PO, and PM pairs, 1.5 seconds in MX pair, and 1.9 seconds in the Alone pair.

(iv) Affiliation. SUMMARY: Animals reared only with a mirror were involved in considerably more Contact Affiliation with their reflections than were all other pairs. Overall, affiliative responses were most frequent on the day of the dye test, especially during the first 5-minute block of the test. One of the two subjects reared alone also exhibited frequent affiliative responses on the fifth day.

Affiliative responses toward the mirror were observed most frequently on Day 5, at a rate of 3.5 responses per 5 minutes. The lowest rate (1.0) occurred on Day 2. The rate analysis yielded a Social Partner X Additional Experience X Form interaction, $F(1, 4) = 9.9$, $p < .05$. MO pair exhibited the most frequent bouts of Contact Affiliation with the mirror, reliably outscoring MX and PO pairs. Figure 34, which shows the Social Partner X Additional Experience X Days X Form interaction, $F(4, 16) = 3.2$, $p < .05$, reveals that MO pair's high Contact Affiliation rate was due to the lastthree days. Rate of affiliative facial gestures toward the mirror were rare, and did not differentiate the pairs, but Figure 34 indicates a small increase in all four pairs from Day 4 to Day 5. Indeed a highly significant Days X Blocks effect ($p = .0001$) indicated that mirror-directed affiliative behaviours occurred most frequently on Day 5 Block 1, i.e., the first block following the marking of the animal's heads.

In the percentage analysis, Additional Experience X Blocks was reliable, as was Social Partner X Additional Experience X Blocks, $F(3, 12) = 6.9$, $p < .0075$. MX animals did not change their amount of affiliative behaviour over blocks. In contrast, MO animals showed most affiliation in Blocks 2 (17.7% of time) and 4 (13.0%), these scores being higher than all MX scores, and higher than MO pair's own scores in Blocks 1 and 3 (LSD = 4.8). The two peer-reared pairs did not differ from one another, their affiliation times varying between 0.3% and 4.6%.

Contact Affiliation with the mirror was more time consuming than Noncontact Affiliation, and was particularly prominent in the MO pair, whose 10% of time in Contact Affiliation was considerably higher than in any other pair (LSD = 4.4), $F(1, 4) = 14.1$, $p < .025$. Peer-reared pairs did not differ reliably from each other, although it is interesting to note that PM animals usually engaged in slightly more affiliation with the mirror than did PO animals. Noncontact Affiliation did not account for as much as 1% of time in any pair.

The remaining reliable effects in the analysis of the percentage of time in mirror-affiliation were: Blocks X Form, Additional Experience X Blocks X Form, $F(3, 12) = 4.6$, $p < .025$, and Social Partner X Additional Experience X Blocks X Form, $F(3, 12) = 7.3$, $p = .005$. In the latter effect, it was notable that Noncontact Affiliation was most prominent in all four pairs in the first block.

Affiliation scores in the two Alone-reared animals are not included in Figure 34 because one of these animals only exhibited two instances of affiliation. The other was quite frequently affiliative toward the mirror, and exhibited a higher rate than any other animal on Day 5.

Mean duration of affiliative episodes in the two main groups was analyzed by a t-test after averaging over blocks and days, because of the absence of affiliative behaviour during several of the blocks. Contact Affiliation bouts with the mirror lasted, on average, 8.5 seconds in mirror-reared subjects, and 5.9 seconds in peer-reared subjects. This was not a statistically significant difference.

(v) Total responsiveness. SUMMARY: MO and PO animals were not differentially responsive to the mirror, both outscoring PM pair, while MX pair were the least responsive. The two infants reared entirely alone appeared to be most responsive of all. Peer-reared animals were more responsive than mirror-reared animals only on the first day of the 5-day period. Overall responsiveness to the mirror increased when the animals' heads were marked, but this increase was only a substantial one for the Alone animals.

Mirror-directed submission, aggression, exploration, play, and affiliation scores were summed to produce a total responsiveness score. In the rate analysis, Social Partner was significant, $F(1, 4) = 11.8$, $p < .05$, as was Additional Experience $F(1, 4) = 70.5$, $p < .0025$, and the interaction between these two variables $F(1, 4) = 10.8$, $p < .05$. Rates for the four pairs were as follows: MO, 43.0; MX, 19.6; PO, 43.2; PM, 33.0. The difference between MO and PO is negligible; all other differences are significant (LSD = 7.8). The total rate for the two Alone animals was 45.4. In the percentage of time anova, Additional Experience was significant, $F(1, 4) = 23.9$, $p < .01$, and Social Partner X Additional Experience bordered on significance ($p = .052$ Percentages were as follows: MO, 35.2; MX, 11.4; PO, 27.9; PM, 21.3.

Rates of responding to the mirror were highest on Day 1 (mean:

46.9 per 5 minutes), lowest on Day 4 (25.6), and they recovered to within Day 1 levels on Day 5 (37.4, LSD = 11.6). Social Partner X Days in rate, $F(4, 16) = 4.0$, $p < .025$; and percentage of time in mirror-directed behaviours, $F(4, 16) = 4.5$, $p < .025$, can be seen in Figure 35. On both measures peer-reared animals initially exceeded mirror-reared animals in responsiveness to the mirror, but the difference did not persist beyond Day 1, due to a decline in the peer-reared scores. Both groups increased responsiveness on Day 5, but neither significantly so. Alone reared subjects appeared the most responsive to their mirror images, and showed increased responsiveness on Day 5 compared to the previous day. Of course Exploration was the biggest contributor to the 'total' category, and Figure 35 resembles Figure 31, which concerns Social Partner X Days in Exploration.

Blocks were ranked in decreasing order of frequency of mirror image reactions as follows: 1, 4, 3, and 2. Both analyses showed Non-contact behaviours to predominate over Contact behaviours, but Social Partner X Form indicated more Noncontact responses in the peer-reared group, $F(1, 4) = 9.1$, $p < .05$. In terms of percentage of time, the mirror-reared group engaged in equal amounts of Contact and Noncontact behaviour with the mirror image (11% and 12%, respectively), whereas peer-reared animals engaged in less contact with the mirror, but more Noncontact 'interaction', (8% and 17%), $F(1, 4) = 8.3$, $p < .05$. There were no other significant effects.

(vi) Overview of home cage mirror-reaction test results. None of the subjects was observed to engage in self-directed activity using the mirror to guide their behaviour, and mark-directed responses were absent during the dye test. Instead, the animals provided an interesting record of responses with regard to the social stimulus

potential of the reflection, with responses varying over days and among the animals, as recapitulated below.

In the way of a ready-reference summary of mirror-directed behaviours in the main experimental groups, Table 17 presents means for exploration, play, affiliation, and total responsiveness over the five days of testing. There was a general habituation in responsiveness over the first four days of the mirror test (e.g., compare Days 3 and 4 in the table), with a restoration of responsiveness on the day of the dye test. This recovery of mirror-directed responses when the animals were marked agrees with findings reported by Gallup (e.g., 1980). In the present study, social responses to the mirror were most pronounced in the first 5 minutes of exposure to the mirror after the animals had been marked.

The above-mentioned trends, especially the increases from Day 4 to Day 5, are also suggested by the exploration and play data in Table 17. Alone-reared animals, however, deviated from the main rearing groups in decreasing Noncontact Play on Day 5, whereas the one Alone subject who exhibited Contact Affiliation on Day 5 did so markedly.

Submission and aggression data have been omitted from the Table, since they occurred relatively infrequently. In general, submissive responses were only exhibited by the two animals that had been reared entirely alone. Interestingly, these two animals also seemed more aggressive toward the mirror than were other subjects. Aggression in general was most common on the first and last days of the test, i.e., on initial introduction to the mirror and when the animals' appearances were altered by marking their heads. However, aggression was generally rare.

One unexpected feature of the data was the generally high and

Table 17. Social behaviour toward a mirror image over 5 days.

Group	Parameter	Form	EXPLORATION DAY 1	2	3	4	5
Mirror-reared	Rate	Contact	6.1	4.7	7.1	3.2	4.4
		Noncontact	19.8	17.7	15.0	10.9	18.3
	Percentage of time	Contact	2.8	5.8	4.9	2.3	2.9
		Noncontact	8.4	10.0	7.5	5.7	10.8
Peer-reared	Rate	Contact	10.8	4.8	3.7	3.1	4.5
		Noncontact	32.5	19.4	18.0	17.6	18.3
	Percentage of time	Contact	7.3	4.3	3.6	2.5	3.7
		Noncontact	15.4	11.0	10.2	10.7	11.3
Alone-reared	Rate	Contact	12.5	8.0	6.6	1.8	6.7
		Noncontact	29.3	21.1	19.1	13.7	17.4
	Percentage of time	Contact	7.3	8.9	5.3	1.0	8.3
		Noncontact	18.3	16.6	11.4	8.5	16.6
			PLAY				
Mirror-reared	Rate	Contact	0.9	0.9	2.1	1.7	4.1
		Noncontact	2.1	4.0	5.2	6.1	8.4
	Percentage of time	Contact	0.4	0.5	1.2	1.0	2.4
		Noncontact	1.1	2.1	3.5	3.8	4.8
Peer-reared	Rate	Contact	8.2	3.1	1.9	0.7	1.8
		Noncontact	10.5	6.6	6.6	3.8	6.0
	Percentage of time	Contact	5.4	1.8	1.4	0.3	1.1
		Noncontact	5.4	4.6	4.2	2.6	3.6
Alone-reared	Rate	Contact	5.0	5.2	4.4	3.6	4.4
		Noncontact	10.8	9.9	11.7	9.1	5.2
	Percentage of time	Contact	3.6	4.0	2.9	2.7	3.1
		Noncontact	7.6	7.9	8.5	6.3	2.9

Table 17 contd.

Group	Parameter	Form	AFFILIATION DAY 1	2	3	4	5
Mirror-reared	Rate	Contact	0.5	0.6	2.4	2.6	2.4
		Noncontact	0.5	0.1	0.8	0.3	1.2
	Percentage of time	Contact	0.3	2.9	9.1	9.2	8.5
		Noncontact	0.5	0.0	0.6	0.2	0.6
Peer-reared	Rate	Contact	1.2	1.2	0.7	0.9	1.2
		Noncontact	0.8	0.3	0.5	0.2	2.1
	Percentage of time	Contact	2.4	1.4	1.3	3.1	0.9
		Noncontact	0.6	0.1	0.4	0.1	1.8
Alone-reared	Rate	Contact	0.0	0.8	0.4	0.3	5.1
		Noncontact	0.3	2.0	0.4	0.4	1.3
	Percentage of time	Contact	0.0	1.6	0.2	0.4	13.8
		Noncontact	0.1	1.7	0.2	0.2	1.0
			TOTAL				
Mirror-reared	Rate	Contact	7.7	6.2	11.7	7.1	11.5
		Noncontact	22.5	21.7	21.1	18.0	28.9
	Percentage of time	Contact	3.6	9.1	15.3	12.6	14.4
		Noncontact	10.1	12.1	11.6	9.6	18.0
Peer-reared	Rate	Contact	20.2	9.1	6.3	4.6	7.5
		Noncontact	43.4	26.2	25.1	21.6	26.8
	Percentage of time	Contact	15.1	7.5	6.4	5.8	5.8
		Noncontact	21.5	15.9	14.9	13.4	17.0
Alone-reared	Rate	Contact	20.0	14.3	11.5	5.3	17.6
		Noncontact	46.0	33.6	30.7	23.5	24.5
	Percentage of time	Contact	14.6	14.7	8.6	4.1	26.4
		Noncontact	29.5	26.3	20.2	15.3	21.0

persistent responsiveness of the two Alone-reared animals to MIS. This finding contrasts with the more limited reactions to MIS and pictorial stimuli in these animals in the tests conducted in the black cage (Section 8.1), and provides further support for the concept of behavioural enhancement resulting from the provision of a moderately unfamiliar environment, as opposed to a grossly unfamiliar one (see Section 7.2.3).

Other effects which were reported and which are also evident in Table 17 include the initially high responsiveness, especially in non-contact behaviours, of peer-reared animals compared to mirror-reared, and the increase in Noncontact Exploration by mirror-reared animals (due to MX pair) on Day 5. However, several of the analyses revealed that the two pairs of monkeys within each main rearing group did not always behave in similar ways, as is summarized in Table 18. The 'additional experience' variable was thus an important one in this respect. MO and PO animals, for example, were equally responsive to the mirror, followed by PM, then by MX pairs. Such differences are important and deserve further elaboration. Animals reared only with a mirror as a companion exhibited over twice as many responses to the mirror as did animals whose (equal) mirror experience had been supplemented by three days per week of living with an agemate on the other side of a transparent partition. Furthermore, animals reared only with a peer in the cage, resembled MO animals in responsiveness to the mirror image. Peer-reared animals given some mirror-experience during rearing were less responsive than MO and PO animals, but more so than MX pair. These patterns are discussed in the following chapter.

The rank order of the pairs as outlined above generally held for individual behaviours as well as for total responsiveness. One clear effect worth reiteration, however, was that MO pair surpassed all other

Table 18. Summary of significant Additional Experience effects in mirror-directed activity.

Behaviour	Parameter	Result	Prob.	Comments
Exploration	Rate	MO + PO > MX + PM	.025	Only the main effect reliable
Exploration	Percentage of time	Day 1: No differences Day 2: MO+PO>MX+PM Day 3: MO+PO>MX+PM Day 4: MO+PO>MX+PM Day 5: No differences	.01	The main effect also reliable, $p < .05$: MO+PO> MX+PM. Results are from the interaction with Days
Play	Rate	Contact: MO + PO > MX, PO > PM Noncontact: MO > MX + PM, PO > MX	.25	The main effect also reliable, $p < .0075$: MO+PO > MX+PM. The interaction with Social Partner and Blocks also reliable, $p < .025$. Results are from the interaction with Social Partner and Form
Play	Percentage of time	Contact: MO + PO > MX Noncontact: MO + PO > MX, MO > PM	.025	The main effect also reliable, $p < .025$: MO+PO> MX+PM. The interaction with Social Partner and Blocks also reliable, $p < .025$. Results are from the interaction with Social Partner and Form
Aggression	Rate	MO + PO + MX > PM	.0025	The interaction with Social Partner and Days also reliable, $p < .00075$. Results are from the interaction with Social Partner

Table 18 contd.

Behaviour	Parameter	Result	Prob.	Comments
Affiliation	Rate	Contact: Day 1: PO+MX>PM Day 2: No differences Day 3: MO>PO+MX+PM Day 4: MO>PO+MX+PM Day 5: MO>PO+MX+PM Noncontact: No differences	.05	The interaction with Social Partner and Form also reliable, $p < .05$: Contact: MO>PO+MX. Results are from the interaction with Social Partner and Form
Affiliation	Percentage of time	Contact: MO > PO + MX + PM Noncontact: No differences	.025	The interaction with Social Partner and Blocks also reliable, $p < .0075$, and the interaction with Social Partner, Blocks and Form reliable, $p < .005$. Results are from interaction with Social Partner and Form
Total	Rate	MO + PO > MX + PM, MX < PM	.05	The main effect also reliable, $p < .05$: MO+PO > MX+PM
	Percentage	MO + PO > MX, MO > PM	.025	The main effect also reliable, $p < .01$: MO+PO > MX+PM

pairs in Contact Affiliation with the reflection. It is notable that only the additionally experienced, MX and PM pairs increased exploration of the image when they were marked, suggesting some greater degree of responsivity to the altered images in these pairs.

From the results described above it can be concluded that the expectation of animals reared only with a peer being particularly responsive toward their reflections was partly upheld. Mirror-Only animals also remained highly responsive, whereas animals with experience of a mirror and one other social condition appeared less attracted to the mirror. The particularly low responsiveness of MX animals, and the high responsiveness of Alone infants were not anticipated. Possible reasons for the obtained mirror-reaction profiles are explored in the Discussion (Chapter 9).

8.3 Interlude

Following the final observation block on Day 5 of the mirror test described in the previous section, the subject was transferred to its appropriate Weekend housing condition, where it remained until the following Monday morning, when customary Weekday housing regimes were re-instated. During the following week, each subject was given a single-session, two-trial preference test in the black cage. The subject could choose among two empty choice chambers, and two chambers one of which led to an adult female stumptail macaque restrained in a transport box, and the other to an adult male in a transport box.

During the following week, each subject was tested with a live juvenile stumptail female in the black cage as follows: On Day 1 the subject and the stimulus animal remained separated from each other by a transparent Perspex partition. After the first hour they were fed, and left overnight with lighting and other amenities provided. They

were returned to their respective home cages the following morning. On Day 2, after the first 15 minutes of the test, the partition separating the animals was removed, allowing them unrestricted access to each other, which is how they remained until being returned to their home cages the following morning. The procedure of initial Perspex-separated exposure, followed by unrestricted access and overnight housing, followed by return to the home cage the following morning, continued for two further consecutive nights, with a total of twelve 15-minute DTU records being made at strategic periods during the procedure.

There were two reasons for carrying out the above procedure. Firstly it was intended to use the resulting data to analyze the responses of the subjects to stimulus animal, and vice versa. However, for a variety of unavoidable reasons five different stimulus animals were used, with a variety of different social histories being involved. Several different animals also served as targets in the choice tests described above. Therefore analyses of these experiments' data has been omitted. A second aim of the interaction sessions was to give the subjects true social experience with an unfamiliar animal, bearing in mind that Gallup et al. (1971) had reported that remedial social interaction resulted in the appearance of self-recognition in isolation-reared chimpanzees. For each subject in the present study, the interaction session mentioned above amounted to approximately 70 hours of interaction. On the Monday following the interaction experience, each subject was re-tested for its reactions to MIS, as described below.

8.4 Home Cage Mirror-Reaction Re-test

1. Procedure. Following the social experiences described in the

previous section, all subjects were re-tested in the mirror test cage used previously. The subject and its diaper were placed into the cage, and its behaviour was recorded for 10 minutes. A 12-key keyboard connected to a clock-counter device (known as the 'green box' because of its colour) was employed to code behaviours (see Figure 3). The duration of time for which each key was depressed was cumulatively recorded by the green box. Three objects toward which the subject's behaviour could be directed were established: mirror image, environment and self. Only mirror-directed behaviours are reported here. Four behaviour categories were employed: submission, aggression, exploration-affiliation combined, and play. The behavioural definitions were those used during home cage testing. All observations in the mirror re-tests were conducted from in front of the observation screen in the nursery, i.e., in full view of the subject.

Following the observation on Day 1, the subject remained in the cage. It was removed briefly before the observation on Day 2, so that the control procedure of wiping the animal's head with a damp cloth could be performed (Section 8.2.2). On Day 3 the dye mark was applied as in the previous test. The subject remained in the cage for one more day after the dye test, the observation on Day 4 being to determine whether the subject's behaviour would change after an extra day's experience of the mirror and dye mark. Thus each animal's record consisted of four 10-minute samples.

Analyses of variance used the same between subjects variables as the previous mirror-reaction tests, and Days (1-4) as the within subjects variable. LSD values were only calculated for statistically reliable anova effects, i.e., $p < .05$.

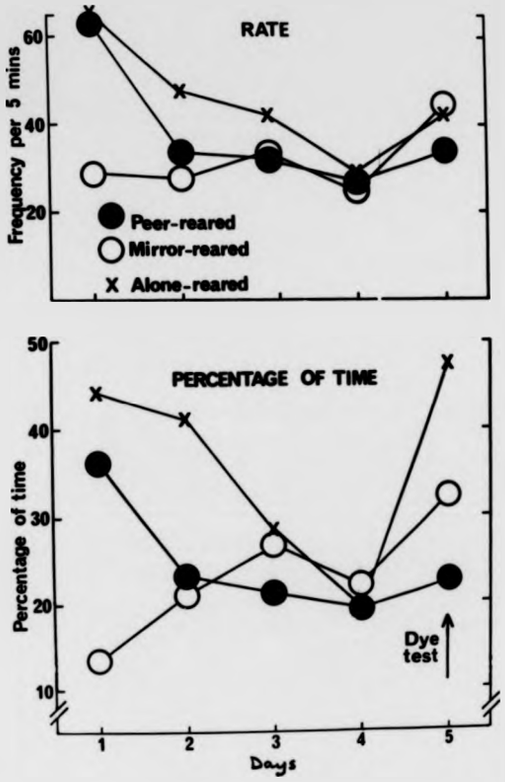


Figure 35. Responsiveness to own mirror image over five days.

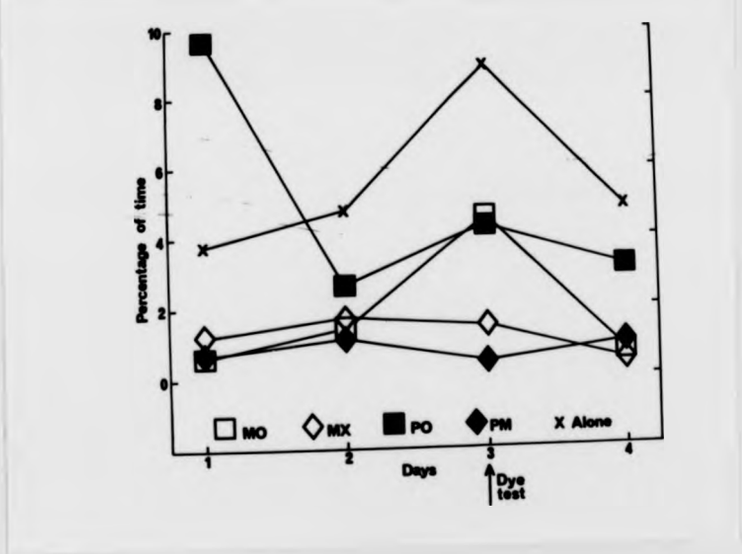
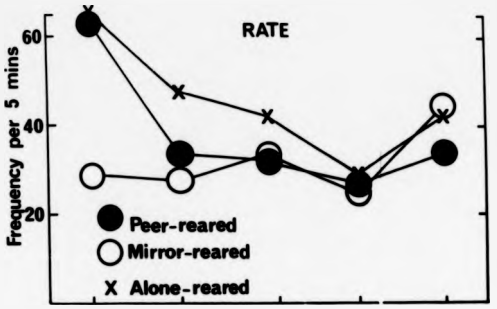


Figure 36. Amount of mirror-directed play during the mirror re-test.



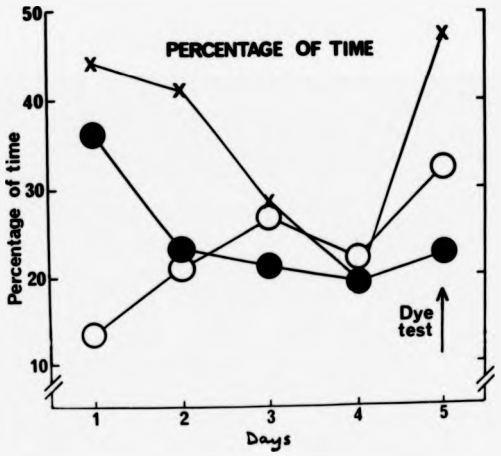


Figure 35. Responsiveness to own mirror image over five days.

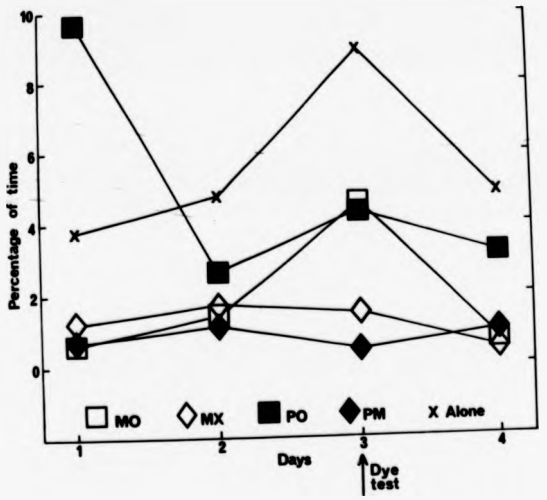


Figure 36. Amount of mirror-directed play during the mirror re-test.

2. Results. SUMMARY: In general, the results of the mirror re-test corroborated the findings from the first test. No animals behaved in a manner which suggested self-recognition. Alone-reared infants appeared more socially responsive to their reflections than did other subjects. Behaviour directed at the mirror image peaked on the day of the dye test, with a sizeable portion of this effect being due to increases in mirror-directed play by MO and PO animals. A striking feature of the data was the high levels of interaction, especially play, by PO animals on their re-introduction to the mirror.

No animals gave any evidence of self-recognition: none of them appeared to use the mirror to inspect their own bodies, and none of them exhibited any mark-directed responses during the dye test. Some of the subjects appeared to attempt to touch the mark on the head of the animal in the mirror.

Apart from one of the two Alone subjects, the monkeys were virtually never submissive toward the image. Aggression was also rare, and it was not affected by any of the variables. Interestingly, however, aggression was 2-15 times more common in Alone-reared subjects than in others (mean mirror-reared: 0.1% of time, peer-reared: 0.6%, Alone-reared: 1.6%).

The only significant effect in the analysis of exploration-affiliation data was the Days main effect, referring to a peak on Day 3, i.e., the first day of the dye test, in which 15% of the 10-minute test was devoted to these types of interaction with the mirror. Of the other three days, Day 1 most closely approached the Day 3 peak, at 11.9%. This finding confirms the increases in exploration and affiliation obtained in the previous dye test. As with the previous exploration score, Alone-reared subjects responded most on Day 1 (23%) rather than on the day of the dye test (17.4%). Their tendency toward high scores compared to the other subjects is also consistent with their behaviour in the original test.

Most effects in the analysis of mirror-directed play were reliable. As before, animals reared only with a mirror or only with a peer (MO and PO pairs) played more than their additionally experienced counterparts (MX and PM pairs), by a factor of 3.5, $F(1, 4) = 9.0$, $p < .05$. The means were 3.4% and 1.0% respectively. The Days effect showed the following decreasing rank order of play with the reflection: Day 1, Day 3, Day 2, Day 4. Also significant were Social Partner X Days, Additional Experience X Days, and the highest order interaction: Social Partner X Additional Experience X Days, $F(3, 12) = 11.3$, $p < .001$ (Figure 36). On Day 1 PO pair played with the mirror image for almost 10% of the test, significantly more than did the other three pairs (LSD = 1.9). This is a deviation from the previous test's results, where PO and MO pairs generally exhibited similar patterns of play. However, by Day 2 PO pair's play score dropped to a level similar to those of the other pairs. On the day of the dye test (Day 3), mirror-play increased in MO and PO animals, to above the levels of MX and PM pairs. The MO pair, but not PO pair dropped significantly on the fourth day. As before, the two subjects reared alone were very playful toward the mirror, as much as, and sometimes more than PO pair. Alone-reared play also rose during the dye test.

Aggression, exploration-affiliation, and play data were summed to provide a responsiveness score. Responsiveness to the mirror was greatest on Day 3, i.e., during the dye test (18.4% of time), followed by Day 1 (15.9%), Day 2 (11.7%), and Day 4 (8.5%). Two interactions were significant: Social Partner X Days, and Social Partner X Additional Experience X Days, both $F(3, 12) = 4.7$, $p < .025$. Overall responsiveness in additionally experienced pairs (MX and PM) did not vary over the four days, whereas total responsiveness did vary over days in the no-additional experience pairs. PO pair's high Day 1 score stood out,

and only in MO pair did the increase on Day 3 reach significance, taking them above the other three pairs. The pairs did not differ in responsiveness on the last day, since MO pair's score dropped. Alone-reared infants spent around 30% of time in mirror-directed activity on Days 1-3, but dropped to near the other pairs on Day 4, at around 15%.

How these findings relate to the first mirror test, along with other findings in the study, are fully discussed in the following chapter. One final experiment is reported below. It was aimed at assessing the effectiveness of a mirror image to act as a social companion for infant stumptail monkeys.

8.5 Mirror Image Stimulation and Peer Separation

1. Introduction. In an experiment concerned with the social stimulus potential of MIS, Gallup (1972) found that the presence of a mirror was able to reduce disturbance vocalizations in chicks separated from familiar peers; in fact a mirror was 3 times more effective than a conspecific behind a transparent partition. Only vocalizations were recorded, no other behaviours. Montevecchi and Noel (1978) reported less agitation in pair-reared chicks tested with a mirror than in group-reared chicks tested with a mirror, and emphasized the discrepancy between rearing and testing conditions as an important consideration.

Pilot work carried out by the present author had suggested that unfamiliar MIS could reduce agitation in adult, group-living stumptail macaques that were temporarily removed from their group. On the other hand, results obtained with the PM pair in the present study provide little evidence of reduced separation protest by a mirror in peer-reared animals. The following experiment was designed to further examine the effectiveness of MIS in reducing agitation in socially separated monkeys, and to compare responses to a mirror image with those with a live conspecific behind

Perspex. Separation from peer-attachment figures was chosen as the most appropriate paradigm, since the mirror image is identical to the subject in physical appearance. Furthermore, it is known that infant monkeys housed together form strong attachments to each other (e.g., Chamove, 1973), and that they reliably exhibit protest, and eventually in longer separations despair, when separated from each other (e.g., Suomi et al., 1970; Suomi, 1974; present Chapter 4).

Three conditions were employed in the present experiment: separation from the familiar environment with an empty neighbouring cage; separation with an unfamiliar peer in the neighbouring cage; separation with a mirror placed between the subject's cage and the neighbouring cage. The empty cage condition was expected to produce the most disturbance. On the basis of Gallup's research with chicks, it could be expected that the mirror would be a stronger elicitor of social responses than would a neighbouring peer, and that it would produce a stronger attenuation of separation protest. The novelty hypothesis of Montevecchi and Noel (1978) would predict a greater reduction of protest in pair-reared monkeys. Alternatively, the presumed advanced ability of monkeys to discriminate among social stimuli, might result in little evidence of reduced separation agitation in the mirror condition in any of the animals.

2. Methods.

(i) Subjects. Two groups of four, mirror-naive stumptail macaques were used. One group, refererred to as the Continuous (CONT) group (2 males, 2 females, Nos. 74, 75, 79, 80), had been reared continuously by their mothers in a group of adults, juveniles, and infants. Ten weeks before the present experiment began these four infants and one juvenile female had been removed from the natal group and housed together in a separate room. At the beginning of testing the mean age of CONT

group was 11.5 months (range 10-13 months). The second group, referred to as the Single-partner-half (SINGHALF) group (1 male, 3 females, Nos: 81, 82, 85, 86) consisted of two pairs. From the age of two weeks each infant in this group was housed with a single other infant for half the time (12 hours per day), the partner always being the other member of the pair. For the remainder of the time the infants were housed alone. Thus SINGHAF animals only had experience of one other animal. At the beginning of testing they averaged 8 months of age (range 6-10 months). Although infants of both groups were used to being handled, SINGHALF group was much more experienced in this respect, being handled every day.

(ii) Apparatus. The experiment was conducted in a testing room unfamiliar to the subjects. Two nursery home cages (Section 3.2.1) were positioned side by side. Each had one wall of transparent Perspex, so that an animal in one cage had an unobstructed view into the neighbouring cage. Behaviours were recorded using the DTU, with behavioural definitions and recording system as in earlier experiments. The only modification was that in the 'empty' condition (see below) the empty cage was treated as a social stimulus for scoring purposes, to allow direct comparisons with the other conditions. Vocalizations were counted on a hand-tally.

(iii) Procedure. Two days before testing began the animals were removed from their home environments, a pair at a time from each group, and placed one into each of the two cages in the test room, where they remained for one hour. Thus each subject experienced one hour of separation from the home environment, during which time it was in a test cage with a familiar peer visible in the adjacent cage.

Testing was carried out over a period of six days, four subjects each being tested once on any day. Each subject was run once in each of three conditions: the neighbouring cage empty; the neighbouring cage containing an unfamiliar infant stumptail macaque; a mirror positioned between the cages, blocking visual access to the neighbouring cage while reflecting the subject's own cage and self-image. The order in which subjects experienced the three conditions was random, with the provision that a stimulus animal was only used once on any day. Two stimulus animals, unfamiliar to the subjects, and aged 9 and 11 months, were used. They were from a trio of infants which had lived as such for several months. During the tests the stimulus animals (1 male, 1 female) exhibited agitation at being separated from their cage-mates. Each stimulus animal was used twice with each group of subjects. During tests which involved a stimulus animal, the subject and the stimulus animal were placed into their respective cages simultaneously. (The author wishes to acknowledge the assistance of F. Bayart in conducting this experiment.) Following the placing of the subject into the test cage, the experimenter sat on a chair 2 metres away, and immediately began to record the subject's behaviour. Each test lasted 10 minutes, at the end of which the subject was returned to its home cage, as was any stimulus animal used.

(iv) Analysis. Behaviours were analyzed in analyses of variance with Group (CONT or SINGHALF) as the between subjects variable, and Condition (EMPTY, MIRROR, or PEER), and Form as within subjects factors. Alpha was set at .05, and LSD values were calculated only for reliable anova effects. Appendix 10 presents F values from all significant effects, and all main effects.

3. Results.

(i) Vocalization. SUMMARY: In SINGHALF animals, the MIRROR and PEER conditions were associated with significantly less vocalizations than the EMPTY condition. Vocalization rate did not vary with conditions in CONT animals.

The Group X Condition interaction, $F(2, 12) = 5.5$, $p < .025$, indicated that vocalization rate did not vary across conditions in the CONT group, averaging around 11 vocalizations per minute. In contrast, SINGHALF vocalization rate dropped from 14 per minute in the EMPTY condition, to 9 and 5 per minute in the MIRROR and PEER conditions respectively. Both of these latter scores were significantly below that obtained in the EMPTY condition, and the SINGHALF PEER score was reliably below the corresponding CONT score. Taking vocalization rate as an index of agitation, these results indicate that both groups were equally agitated when they were entirely alone, that CONT animals were equally agitated in all three conditions, whereas SINGHALF animals were less agitated in the presence of a mirror or an unfamiliar peer than when they were entirely alone.

(ii) Submission and aggression. SUMMARY: There were too few agonistic data to merit statistical analysis. However, these behaviours appeared to be elicited most frequently by the mirror, especially in the CONT group.

Submissive responses were never exhibited toward either the empty chamber or the peer behind Perspex. Three CONT animals exhibited submissive gestures toward the mirror, as did one SINGHALF infant. Instances of aggression occurred as follows: one animal in each group kicked against

the partition separating the two cages in the EMPTY condition, and these were recorded as aggression. Only one CONT animal displayed aggression toward the peer (3 times); no SINGHALF animals did. Three CONT animals exhibited aggression to the mirror, two doing so over 20 times in the 10-minute test. One SINGHALF subject exhibited one brief aggressive response to the mirror. Despite not being analyzed formally, the above observations suggest that the CONT group responded more agonistically toward the mirror than did the SINGHALF group.

(iii) Exploration. SUMMARY: In both rate and percentage of time, the EMPTY condition elicited least exploration from the subjects, while the PEER condition elicited the most. The mirror was intermediate. The above differences were clearest in the rate of Noncontact Exploration. CONT group explored the stimuli for longer than did SINGHALF group.

The two groups of subjects did not differ in their rates of exploring the three stimulus conditions. Condition produced a highly significant effect, as did Form, and the interaction between these two variables was reliable, $F(2, 12) = 4.8$, $p < .05$. Contact and Noncontact Exploration of the neighbouring cage did not occur at different rates when the cage was empty (Figure 37, LSD = 7.1). Nor did rate of Contact Exploration vary significantly across the three conditions. However, Noncontact Exploration was twice as frequent in the MIRROR condition as in the EMPTY condition, and even more frequent in the PEER condition.

Overall, CONT group spent slightly more time exploring the stimuli (23.5%) than did SINGHALF group (18.2%), $F(1, 6) = 5.9$, $p < .05$. The three conditions elicited the following amounts of exploration: EMPTY, 12.4%; MIRROR, 19.2%; PEER, 31.0%, $F(2, 12) = 14.2$, $p < .001$. Noncontact Exploration accounted for over twice as much time as Contact Exploration,

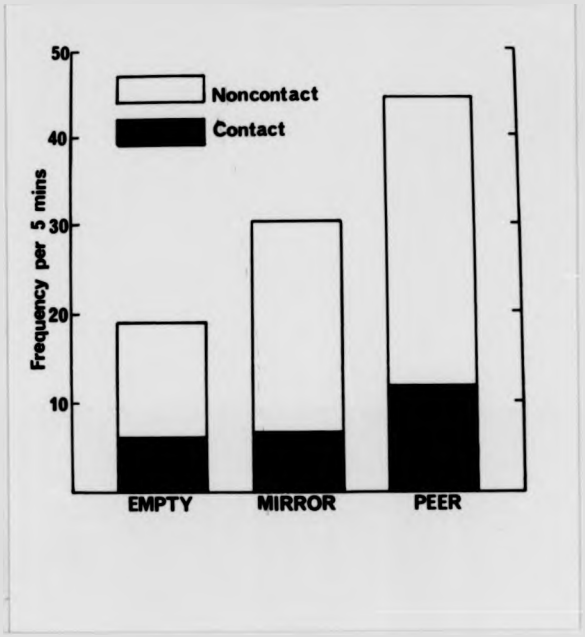


Figure 37. Rate of exploration of three neighbouring cage conditions.

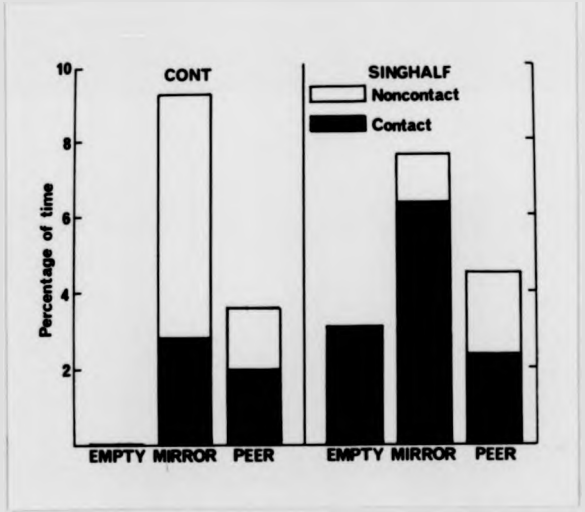


Figure 38. Amount of affiliation in three stimulus conditions.

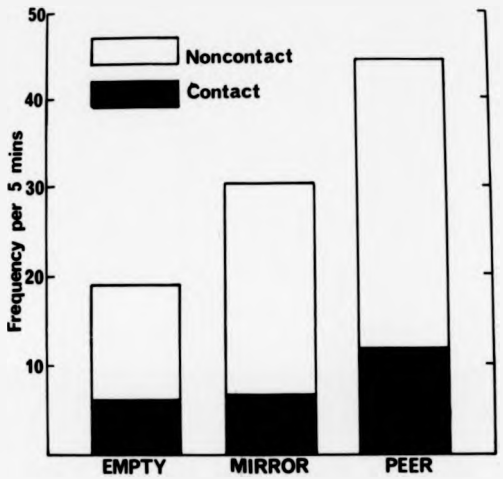


Figure 37. Rate of exploration of three neighbouring cage conditions.

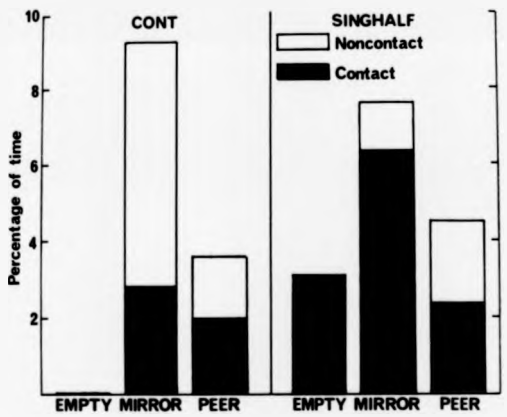


Figure 38. Amount of affiliation in three stimulus conditions.

14.2% and 6.6% respectively. The analysis of exploration bout lengths yielded no significant effects.

(iv) Play. Not surprisingly, given the unfamiliar environment and the separation procedures, play was extremely rare. One animal exhibited a few behaviours scored as play during the EMPTY test, three (2 CONT, 1 SINGHALF) during the PEER test, and one (CONT) in the mirror test. No conclusions can be drawn about the groups or conditions from these instances.

(v) Affiliation. SUMMARY: The mirror elicited the greatest amount of Noncontact Affiliation in CONT group, and the greatest amount of Contact Affiliation in SINGHALF group. These two high scores were the dominant features of the affiliation data.

Rate of affiliation was not affected by the independent variables. Regarding the percentage of time in stimulus-directed affiliation, Group X Condition X Form was significant, $F(2, 12) = 4.3$, $p < .05$. Figure 38 clearly illustrates the most striking feature of this interaction. In both groups the MIRROR condition produced a relatively high affiliation score. In CONT group, the mirror elicited Noncontact Affiliation, i.e., lipsmacking and/or pouting, for over 6% of the test, otherwise this group's affiliation scores did not reach 3%. In SINGHALF group, the mirror elicited Contact Affiliation for over 6% of the test, while this group's other affiliation scores were less than half of this.

(vi) Total responsiveness. SUMMARY: The MIRROR and PEER conditions elicited more social behaviour than did the EMPTY condition. The two

groups of subjects were found not to differ in overall responsiveness to the stimulus conditions.

Submission, aggression, exploration, play, and affiliation scores were summed into a total responsiveness category. The two groups never differed from each other in overall responsiveness. Together, the subjects reacted differentially to the three conditions. Social behaviours were clearly more frequent in the MIRROR and PEER conditions than in the EMPTY condition, $F(2, 12) = 14.6$, $p < .00075$ (mean rates: 43, 50.5 and 20.5, respectively). This pattern also emerged in the percentage of time analysis, $F(2, 12) = 12.0$, $p < .005$, with means of 30.6%, 35.6%, and 14.6% respectively. Noncontact behaviours were over twice as common as contact behaviours. The only remaining result was Condition X Form in the rate analysis, $F(2, 12) = 4.5$, $p < .05$, which produced a pattern similar to that obtained from the exploration data (see Figure 37).

(vii) Dependency between behaviours. SUMMARY: When the peer was present behind Perspex, the probability of Contact Exploration occurring immediately after Noncontact Exploration, was greater than it following some other behaviour. This dependency was not found in the MIRROR condition.

As a test of whether the abnormal feedback from a mirror image affected the temporal organization of responses by viewing animals, a preliminary analysis of a sequential dependency between the two most common responses was assessed as follows. The probability of Contact Exploration immediately following a bout of Noncontact Exploration was determined by comparing $p(A_n/B_{n-1})$ with $p(A_n/\bar{B}_{n-1})$, where A_n is the occurrence

of Contact Exploration as the nth event, B_{n-1} is the occurrence of Noncontact Exploration as the preceding event, and $\bar{B}_{n-1}$ is the occurrence of an event other than Noncontact Exploration at n-1. This exercise revealed that in the PEER condition, the probability of a bout of Contact Exploration immediately following Noncontact Exploration (.14) was greater than the probability of Contact Exploration following some other event (.10), $p < .05$. In the MIRROR condition, however, the corresponding probabilities did not differ reliably: .08 and .06 respectively.

(viii) Overview of MIS and peer-separation results. Combining both groups of subjects, vocalizations were not significantly fewer in the presence of a mirror than in the presence of an empty neighbouring cage. Therefore the mirror cannot be said to have reduced separation-induced agitation in all of the monkeys. However, the presence of a mirror or an unfamiliar peer in the neighbouring cage resulted in markedly fewer vocalizations in the SINGHALF group, but not the CONT group. This result is compatible with the finding of Montevecchi and Noel (1978), who obtained a greater reduction in peeping vocalizations in pair-reared chicks than in group-reared chicks when they were tested with MIS. One possible reason for the group difference in the present experiment could be that SINGHALF animals, because of their relatively restricted social contact with the partner, were less attached than the much more socially experienced CONT infants. However, the fact that in the EMPTY condition both groups appeared equally agitated, suggests that a more likely reason for the obtained results lies in the way the two groups of animals perceived the mirror and the peer, as discussed below.

The obtained patterns of agonistic behaviour in the two groups

of animals suggests that the mirror and peer were differentially perceived by the two groups. There was some evidence of more intense agonistic responses to the mirror by the CONT group compared to the SINGHALF group. One possibility is that the stronger agonistic overtones of the situation contributed to the mirror's inability to reduce agitation in the CONT subjects.

Another aspect of the data supports the notion that CONT animals reacted to the mirror with greater ambivalence than did SINGHALF animals. Whereas the mirror elicited a relatively large Contact Affiliation in SINGHALF subjects, CONT animals exhibited a large amount of lipsmacking in this condition. This aspect, and those discussed above, suggest that the CONT animals were more xenophobic in their reactions to the mirror than were SINGHALF animals, and that this feature of CONT group's behaviour was incompatible with reduced agitation. The negative component of the CONT group's reaction to the mirror may be at least partly attributable to the abnormality of the reflection's behaviour. This possibility received some support from the finding that agonistic and noncontact affiliative gestures were not so evident in the PEER condition as in the MIRROR condition.

In contrast to the discriminating CONT animals, SINGHALF infants, if they detected the abnormality of the behaviour of the reflection, did not react negatively toward the mirror, but approached it in an affiliative manner, attempting to achieve gross bodily contact with the image. In fact these subjects did appear to react differently to the peer behind Perspex and the mirror image, in as much as the former stimulus almost produced a significantly lower rate of vocalization than the mirror, and the peer elicited more exploration.

In both groups Noncontact Exploration, i.e., looking without touching, was most prominent in the PEER condition, followed by MIRROR

and then EMPTY. A reasonable conjecture is that the highly socially experienced CONT animals immediately recognized the peer as being unfamiliar, which therefore produced high levels of exploration, but no quiescence. In contrast, the less socially sophisticated SINGHALF animals might have been less sensitive to the stimulus animal's identity, which is supported by the high levels of Contact Affiliation exhibited toward the peer. Alternatively, animals reared in a regime such as the SINGHALF condition, might be sensitive to familiarity, but be primarily affiliative toward new social objects, since their relatively limited social experience has not refined agonistic behaviours in the way in which a richer social milieu would.

The following chapter discusses the results of this experiment, and findings reported earlier, in the context of existing literature.

* Some of the results reported in the present study were obtained with only two subjects in the experimental conditions. It is therefore possible that some statistically significant results arose due to sampling error, i.e., the requirements of analysis of variance not being entirely fulfilled. These results should not be considered definitive, but rather suggestive. Similarly the failure to obtain reliable differences between pairs of subjects on some measures could reflect limitations of the small sample sizes, and ceiling effects, rather than true absences of differences. These negative findings must also be taken with caution.

CHAPTER NINE. DISCUSSION

The main empirical findings of the present study will be discussed according to the three main areas of interest which were established, namely behavioural development of mirror-reared compared to peer-reared infants, social stimulus properties of MIS, and self-recognition following extensive mirror experience. *

9.1 Behavioural Development

Two of the issues under investigation were (i) the extent to which a mirror could compensate for the absence of true social experience during infancy, and (ii) whether attachments formed to reflections would be comparable to those formed to cagemates. These will be discussed in turn.

If mirrors could not compensate for the absence of peer experience, then mirror-reared animals should have exhibited an 'isolation syndrome' similar to that reported in other socially deprived macaques (see Chapter 2), and this should have been more marked than in peer-reared animals. However, there was little in the home cage data to suggest that mirror-reared animals were any more adversely affected by their rearing conditions than were peer-reared animals (Chapter 4). In the early months mirror-reared animals did exhibit more abnormal behaviours than peer-reared subjects, suggesting that physical contact is important in very young infants, but in later months the peer-reared group exhibited 'isolation syndrome' activities as much as mirror-reared animals. The peer-reared increases in abnormal behaviours were largely due to the PM pair. This suggests that the 'additional experience' treatment might have caused some disturbance in these animals. It is not clear from the data whether this effect was due to the abnormality

of MIS experienced at weekends by the PM pair, or whether housing with another social stimulus would have produced similar effects.

The two animals reared entirely alone exhibited the most isolation syndrome behaviours. They also engaged in self-directed play three times as much as other animals. This behaviour, which involves the infant rolling around and pulling and biting gently at its own limbs and torso, has been noted in other isolation-reared macaques (Baysinger et al., 1972; Berkson, 1968), and is thought to be a precursor of later self-aggression (Anderson and Chamove, 1980, 1981). Self-looking was also most characteristic of the alone-reared monkeys, agreeing with this finding in rhesus by Baysinger et al. (1972).

Taken together, the results considered above constitute evidence of the presence of a mirror reducing the tendency toward certain self-directed behaviours in infants otherwise housed alone, and partly reducing the tendency toward isolation syndrome behaviours. It was also found that alone-reared subjects were unresponsive to slides of conspecifics, compared to mirror- or peer-reared animals (Chapter 7; see Sackett, 1965 with regard to adult rhesus). Contact Affiliation responses, in particular, were virtually nonexistent in monkeys reared entirely alone. The slide-reaction tests also detected some differences in responsiveness to the content of pictures in peer-reared and mirror-reared animals. This implies that while home cage activity might be grossly similar in mirror-reared and peer-reared animals, mirror rearing might not produce the normal pattern of development with regard to communicatory functions.

The second major question surrounding behavioural development concerned the strength of social attachments formed by the infants. Evidence of peer-attachments being stronger than mirror-attachments was obtained, in the form of (a) greater behavioural disruption, i.e.

increased diaper-contact and self-orality, in peer-reared animals when tested in a very unfamiliar environment (Chapter 7); (b) decreases in play by peer-reared animals during weekend separations (Chapter 4); and (c) increased diaper-contact in peer-reared animals at weekends. Furthermore, although Weekday vocalization rates were similar in mirror-reared and peer-reared animals, the switch to weekend (separation) housing was associated with marked increases in vocalization only in the peer-reared group. This also suggests greater agitation at social separations in the peer-reared group. In the present study, therefore, true physical contact (see e.g., Harlow, 1971) appeared to be more related to attachment formation than did visual proximity (e.g., Cairns, 1966).

Although alone-reared and mirror-reared animals exhibited some negative reactions to unfamiliar environments, signs of disturbance were clearly more evident in the peer-reared group. Socially-reared rhesus monkeys also reacted more strongly to separation and placement in an unfamiliar environment than did isolates (Brandt et al., 1972). In terms of attachment, mirror-reared animals more closely resembled alone-housed subjects than peer-housed subjects.

One objective of the present study was to obtain data which would allow some comparisons of the effects of restricted social experience in stumptail macaques, with those known to occur in better studied species. It was recently reported by Seckett et al. (1981) that the severity of the isolation syndrome varied in isolates from three macaque species. Rhesus engaged in most isolation behaviours in their home cages, around 50% of the time. Crab-eating macaques performed abnormal behaviours 25% of the time, which agrees quite well with Berkson's (1968) figure of around 20% of intervals from a one-zero technique. Home cage isolation syndrome behaviours were least

evident in pigtail macaques, who obtained scores of less than 5%. In the present study, the two stumptail macaques reared entirely alone exhibited autoerotic behaviour during 10.9% of Weekday intervals, self-clasping in 2.6%, stereotypy in 0.4%, and bizarre postures in 4.5% Since there was some degree of overlap among these behaviours in observation intervals, the total percentage of intervals in which the animals performed at least one isolation syndrome behaviour is less than the sum of the above intervals. When corrected for overlap, it emerges that isolation syndrome activity occurred in 17% of intervals in the two most socially deprived animals. Since the modified frequency system of sampling employed here correlates highly with true duration measures (e.g., r = .63 - .99, Chamove 1974a), the obtained score is probably representative of the true duration. These results suggest that stumptails be placed alongside crab-eating macaques in exhibiting a moderate to mild aberrant personal behaviour syndrome during early social restriction. Riesen et al. (1977) reported that over a 6-month period, 'self-clutch', 'bizarre orientation'; and 'self-bite' each occurred less than 5% of time in stumptail isolates. Although these behaviours were virtually nonexistent in socially-reared controls, the incidence of abnormal activities in the isolates seems sufficiently low to support the contention that stumptails exhibit a mild isolation syndrome. It also seems likely that stumptails resemble crab-eating macaques (Sackett et al., 1981) in rapidly performing positive social interaction following early social deprivation (Chamove, in preparation; personal observations).

It is also interesting that Berkson (1968) could not distinguish between isolate and socially-reared crab-eating macaques in home cage manipulatory and oral activity. These activities also failed to distinguish stumptails in different home cage conditions in the present

study. It is possible that in M. arctoides and M. fascicularis these behaviours are robust aspects of behavioural development. In contrast, self-orality clearly distinguishes infant isolates from controls in rhesus monkeys, M. mulatta (Baysinger et al., 1972; Griffin and Harlow, 1966). This reinforces the notion of a species difference in stumptails' and rhesus' responses to social restriction in early life.

As suggested by Anderson and Chamove (1980) socially restricted stumptails did not exhibit much stereotypy, e.g. it occurred in less than 1% of intervals in Alone-reared subjects. However, the expected prominence of self-aggression was not confirmed. Five of the animals remain in the laboratory, in a group of over 20 animals. They are all being monitored for self-aggression.

Some aspects of the slide test data provided evidence of basic response tendencies in the infants, as suggested by Sackett's (1966) research. For example the infants appeared more attentive to slides of infants than of adult females, and they were less likely to contact adult male threat pictures. On the whole the slide test results suggested the following decreasing order of the animals in responsivity to slides of conspecifics: peer-reared, mirror-reared, and alone-reared. However, the virtual absence of play responses during presentation of the pictures, and the later finding of high responsivity to MIS in alone-reared animals during home cage tests (see following section), suggest that reactions to the slides were contaminated by adverse reactions to the test setting. Although the animals had been adapted to the test cage for at least one month, it seems likely that they were not fully adapted to the situation. In some contrast, the moderately unfamiliar, new home cage tended to encourage environment-directed activity while decreasing self- and diaper-directed activity (Chapter 7). It is conceivable, therefore, that responsiveness to pictorial stimuli

would be enhanced in an environment in which the subjects are more confident.

Of course behavioural development of the subjects cannot be adequately discussed without reference to the influence of the social partners available to the infants. For example it seems reasonable to suggest that vocalization in alone-reared animals was relatively infrequent due to the absence of any socializing agent to elicit and modify this aspect of behaviour. The literature on rhesus isolates is in general agreement with the trends obtained in the present study. Adult isolation-reared rhesus use coo vocalizations infrequently in social situations (Mitchell et al., 1966), and during rearing (Brandt et al., 1972). In the latter study, isolates also vocalized more when they were separated from their rearing environments, but much larger increases occurred in socially separated infants (see present Chapter 7). It appears that the two alone-reared animals in the present study were more vocal than the rhesus isolates studied by Brandt et al. (1972), suggesting a possible species difference in response to social restriction. The fact that mirror- and peer-reared animals did not differ in Weekday vocalization rate suggests that the reflection was perceived as a social stimulus to a certain extent.

The expected higher prevalence of diaper-contact in alone- and mirror-reared animals compared to peer-reared, was contradicted by the data. One possible reason for higher levels of diaper-contact in peer-reared animals is that true social rearing inevitably involves some degree of social stress, for example through competition or some other agonistic context (e.g., Chamove and Bowman, 1976). Indeed aggression was eventually more evident in peer-reared animals (Chapter 5). The absence of a competitive or independently aggressive partner in the mirror condition could account for the lesser reliance on the

diaper for contact confort in mirror-reared animals. Consideration of differences in the potential for independent action in the social partners, leads directly to the second major issue under investigation, i.e., the sociality of the stimuli employed.

9.2 Social Stimulus Properties of MIS

In gross terms the mirrors clearly constituted a social stimulus for the monkeys, and in terms of correlations among activities or measures of behaviour, MIS did not appear to differ from true peer-stimulation. Without doubt, however, peer-rearing produced more social activity than did mirror-rearing (Chapter 5). Total time spent in behaviour with a fully accessible peer was 50% more than the corresponding mirror value.

A major difference between a mirror and a peer is that only the latter stimulus has the potential for authentic, three-dimensional, tactile contact, and this factor appeared important in the development of social attachments in the infants (see above). Surprisingly, however, Contact Affiliation was not more common in the peer-reared group. In contrast, Contact Play was 3 times more common in peer-reared than mirror-reared monkeys, implying that this behaviour, rather than Contact Affiliation was the main expression of an affiliative relationship in the peer-reared animals. Contact Play in mirror-reared animals involved lunging at the reflection and attempting to wrestle with, and gently bite the reflection. Of course it was impossible to deliver full play bites to the mirror, and true rough and tumble play was unattainable with the mirror. In many instances mirror-play became mixed up with self-directed play. However, the fact that the mirror did elicit play responses, and the finding that animals huddled against their mirrors as much as peers huddled with each other, indicates that the reflection did possess social stimulus properties. It is also evident that certain affectional response systems are

sufficiently robust to continue to operate in the absence of normal sensory consequences, although the emotional consequences may be altered.

In addition to differing in the potential for physical contact, a mirror and a fully accessible peer differ in that the latter stimulus has greater unpredictability and independence. Although positive feedback from a reflection might maintain behaviours emitted by a viewing animal, the animal is always the primary determinant of whether an 'interaction' will occur, and when it will be terminated. With a live peer, however, an additional source of variation is present. The peer may or may not respond to a gesture from the subject, and vice versa, whereas a mirror always only ever responds, if abnormally. With a peer, once an interaction is underway, both animals can independently act to terminate or continue the episode. It is conceivable that these aspects of the social stimuli were involved in the greater daily variability in engagement in play in the peer-reared group, and their more variable Contact Play bout lengths (Chapter 5). These data also further confirm the importance of physical contact in behaviour in infant monkeys.

Compared to a fully accessible cagemate, a mirror image cannot be properly contacted, and it behaves abnormally, i.e., it only replicates the subject's actions; it never initiates, terminates, or modifies interaction. What was the most important factor underlying the differences in social behaviour in mirror-reared and peer-reared animals, impossibility of physical contact, or abnormal organization of responses? By comparing responses to cagemates in peer-reared animals with responses to a peer behind Perspex in Mirror-Perspex animals, it could be determined to what extent a social stimulus which was capable of normal, independent action, but which could not be contacted, would support interaction.

The relevant analysis (Chapter 6) revealed twice the incidence of social behaviour toward the cagemate as toward the peer behind Perspex. Once again, this effect was clearest in play, with aggression also tending to be more prevalent with a fully accessible peer. In fact the impression gained from observation of animals in the Perspex condition was that apart from some visual exploration, there was little reciprocal behaviour with the animal in the neighbouring cage. Contact Exploration bouts did increase in length over months, indicating that interest in the other animal was gradually developing, but on the whole there was little sustained attempt at interaction with the neighbour, in contrast to the situation with a peer inside the animal's own cage.

Clearly, a peer which was visually but not physically accessible supported diminished social performance relative to a fully accessible cagemate. How does a peer behind Perspex compare to a mirror image? Both situations represent a partner which the animal can never really contact, but the mirror image also constitutes a behaviourally peculiar stimulus which only ever imitates, while the peer behind Perspex is an independent agent which is also capable of engaging in well structured interaction sequences. The analysis in Chapter 6 showed that MX pair interacted more frequently with their mirror images than with each other through Perspex. The mirror elicited more play and more affiliation in early months. The only evidence of superiority of the Perspex condition was the increasing tendency toward long Contact Exploration bouts. On the whole, however, the imitative reflection received a greater social response than the independently moving, more complex peer behind Perspex.

From the results discussed so far, the following decreasing order can be drawn up with regard to the amount of social behaviour

observed in each stimulus condition: a fully accessible peer, a mirror, and a peer behind Perspex. This order is based upon the home cage behaviour sampling carried out over a 5-month period. The peer-separation experiment carried out with eight additional infants (Chapter 8) also directly tested the relative potency of a mirror and a peer behind Perspex. In this case, the stimulus animal and the mirror image were both unfamiliar to the subjects, who varied in social sophistication. One group was formed from pair-reared infants, and one group from group-reared infants.

It was found that overall responsiveness to the two stimuli was approximately equal. In terms of individual behaviours, the peer behind Perspex attracted more exploration than did the mirror, whereas the mirror elicited more noncontact affiliation, and possibly more agonistic responses, in group-reared monkeys. It seems reasonable to suggest that the abnormal behaviours of the reflection were responsible for the increased lipsmacking and agonistic responses in the group-reared infants. It is not clear from the data, however, whether this effect resided in the abnormalities being detected and responded to by the animals, or whether a perpetuation of these responses, once emitted, occurred, due to a positive feedback effect from the image, as identified in mirror tests with other animals (see Chapter 1). The latter effect might be expected to show up in longer behavioural bouts in the mirror condition, but the difference in length of Noncontact Affiliation bouts to the mirror (2.2 seconds) was not reliably longer than the equivalent peer score (1.7 seconds).

The finding of a mirror-induced reduction in separation protest in pair-reared but not group-reared infants in these short tests, corresponds well with results obtained by Montevecchi and Noel (1978) with chicks. In the pair-reared animals, although the peer behind Perspex

elicited more exploration than the mirror, the latter stimulus elicited more Contact Affiliation. Integrating the results from the peer-separation experiment with the home cage data discussed earlier, it appears that infants with social experience restricted to one social partner display more positive responses to a mirror than to a peer behind Perspex. This was evident in play responses in the MX pair, and in contact forms of affiliation in the MX pair and in the pair-reared monkeys in the separation experiment. Measures of exploration, however favoured the peer behind Perspex. On the other hand, more sophisticated, group-reared infants reacted more ambivalently to the peculiar activities of the animal in the mirror in the separation experiment.

Of course the behaviours of the animals in the separation experiment were influenced by the experience of being separated from their normal environments. The reactions of peer-reared animals to mirrors were also assessed by observing the Weekend behaviours of the PM pair during the five months of home cage testing (Chapter 6). Although some agitation at social separation was also evident in these subjects, they were much less disturbed than the animals in the later separation experiment. The PM animals engaged in twice as much Contact activity with the cagemate as with the mirror. Compared to mirror-reared infants, PM monkeys engaged in very short bouts of Contact Affiliation with the mirror. However, they exhibited more play with the reflection than did MX animals, and in fact were just as responsive overall to the mirror as were MX pair, both of these pairs being less responsive than MO pair. In sum, while the PM animals exhibited some positive social behaviours to a mirror throughout infancy, they did this less so than to a cagemate, and less so than mirror-only reared animals did to their mirrors.

In general, it appeared that the additional experience given to the MX pair at weekends, in the form of a peer behind Perspex, caused a

diminution of their responsiveness to the mirror. This occurred in spite of the lack of evidence for the peer behind Perspex eliciting more social responses than the mirror. In contrast, additional experience in the form of MIS given to PM animals, had minimal impact on their peer-oriented behaviour. This suggests that the social stimulus properties of a mirror are more fragile than those of a live, fully accessible peer.

The comparison of reactions to MIS with those to a moving film of a conspecific were interesting because the film represented a moving animal whose behaviour was entirely out of synchrony with the subject's actions. MO animals, for whom the film was the first introduction to a moving conspecific stimulus other than their own mirror images, were the only animals to explore the film more than the mirror (Chapter 8). The other animals with experience of a moving peer tended to explore the mirror more, but the difference only reached significance in the mirror naive, PO pair. For these animals, the irrelevant actions of the animal in the film appeared less compelling than the continuously reciprocating animal in the mirror (see Meliska and Meliska, 1980, for a similar finding with Betta splendens), whereas the novelty of independent movement evoked increased exploration in MO animals. Interestingly, Alone-reared animals also clearly responded more to the mirror than to the film, presumably due to the lower complexity of the mirror image compared to the unpredictable animal in the film.

During the 5-day home cage mirror test, the greater responsiveness of MO animals compared to MI infants was as evident as it had been during earlier stages of the study. In the 5-day test the PM pair also surpassed MI animals in responsiveness. More striking, however, was the finding of animals reared only with a mirror (MO) or only with a peer (PO) both exceeding the additionally experienced MI and PM pairs in

mirror-responsiveness, at least in exploration and play. These trends generally endured in a re-test two weeks later, after all of the subjects had experienced approximately 70 hours of social housing, with a juvenile female conspecific.

It seems likely that the high levels of responsiveness of the Peer-Only monkeys in these mirror tests depended on different mechanisms from those involved in the behaviour of mirror-only-reared animals. For PO monkeys the mirror was a novel stimulus: the identity of the animal in the mirror, the inability to achieve true contact with it, and its movement patterns were all novel, whereas this was clearly not so for MO animals. Therefore it is probable that novelty enhanced responsiveness in PO animals, whereas MO animals remained responsive because a mirror was the only social companion they had experienced.

The most outstanding finding from the home cage mirror tests was the high degree of responsiveness in the two Alone-reared animals. Their behaviour in these tests contrasted markedly with that observed in tests conducted in the black cage, where they consistently exhibited diminished responsiveness to social stimuli. This finding again draws attention to the importance of the test environment in social behaviour tests.

The research discussed so far indicates that the social history of a monkey is an important determinant of how it will react to MIS, as suggested by the results of Gallup and McLure (1971), and intimated in 1929 by Yerkes and Yerkes in their discussion of apes. When tested in familiar surroundings, socially inexperienced infants are highly responsive to mirrors. Animals reared only with a mirror also maintain a readiness to respond socially to the image, although the social responses differ in some ways from those exhibited in the presence of a real cagemate. Additional social experience reduces mirror-responsiveness

in mirror-reared animals. Infants reared exclusively with one peer also respond positively to MIS, more so than do group-reared monkeys, whose reactions are at least partly negatively influenced by the behavioural peculiarities of the image. These trends emerged when reactions to MIS were compared with reactions to a conspecific behind Perspex (Chapters 6 and 8).

In conclusion, it would seem likely that long-term mirror studies of other species, incorporating multiple measures of several behaviours, and considering variability and correlational parameters, might help better identification of mechanisms involved in social behaviour.

9.3 Investigation of Self-recognition

In spite of the innovations of the present study, namely the instigation of MIS at the early age of 2 months, the use of a triple mirror image effect inside the animals' home cages, and extending the previous mirror exposure record by over 1,000 hours to approximately 3,500 hours, even the most mirror sophisticated animals in the present study gave no indication of self-recognition.

Shortly after these tests, the animals were housed in a group of between 6 and 8 monkeys in a large cage for between 8 and 10 months. Monday to Friday each week a 96 X 96 cm. mirror remained one metre away from the cage, allowing the animals to view the reflection of themselves and each other. Following approximately 6 months of this housing, some of the subjects went into a group of over 30 animals in an indoor-outdoor facility (described in Chamove and Anderson, 1979). The animals were given two 10 X 10 cm. mirrors, protected in a wooden frame. The monkeys could pick up and carry these mirrors around (Figure 39) for as long as the wooden frame lasted, which was over two months. None of the animals (1 MO, 2 MI, 1 PO, 1 PM) which remain appear to use the mirrors in a manner suggestive of self-recognition.

During the earlier tests, there was evidence of habituation to the reflection, followed by a recovery of interest when the animals were marked, as has also been reported by Gallup (e.g., 1977b; Gallup et al., 1980). Social responsiveness to the mirror image was most prominent in the first 5 minutes on the day of the dye test, a trend which was clear with regard to lipsmacking, a gesture of affiliation or appeasement. The question arises as to why the dye test should increase social responsiveness toward the reflection. One possibility is that by marking the animal, the identity of the mirror image becomes unfamiliar, thereby causing increases in appropriate social responses. While this seems plausible for relatively mirror-naive subjects, it is unlikely that animals reared with a mirror would be unable to recognize the individual in the mirror simply because a red mark had been made on its head. It seems more probable that increased lipsmacking represents a desire in the subject to gain proximity to the animal and attempt to investigate or groom it, as often happens when monkeys discover wounds or marks on their companions.

The present study certainly does not challenge the view of Gallup (e.g., 1975, 1977a) that monkeys may lack a sufficiently well developed concept of self to enable them to exhibit self-recognition. However, some investigators (e.g., Griffin, 1976; Humphrey, 1976) would seem to imply the existence of an internal self-representation in animals which is involved in sophisticated social behaviours, and Mitchell et al. (1979) postulate that a disturbed self-concept may be involved in the self-aggression which develops in isolation-reared macaques. The extent of self-awareness in monkeys and other species remains a largely unknown area. Three approaches which might help to clarify the situation are proposed below. These include: further developments in the MIS-self-recognition paradigm, documentation of other behaviours which might

suggest the presence of self-awareness, and the potential of other techniques to demonstrate visual self-recognition.

1. MIS and self-recognition. The present study began mirror experience with the youngest infants yet used in such research, extended the previous published exposure record, and utilized a triple mirror image effect. Techniques within this paradigm could be further developed. For example by forming a 60° angle between two mirrors five reflections become visible, rather than three as in the present study. Also, mirrors can be arranged so that the animal's reflection faces away, eliminating the possibility of gaze aversion interfering with the emergence of self-recognition (a possibility considered but discounted by Gallup et al., 1980). Hall's (1962) report, and personal observations (see Figure 39) also suggest that provision of small, portable mirrors maintains the animals' interest, and extends the diversity of reflections. Gallup (1979) intends to assess the effects of a lifetime of exposure to MIS on self-recognition in pair-housed monkeys. This approach, along with more intensive short-term projects incorporating some of the techniques outlined above, should provide useful information.

An additional method, still based on mirrors, would involve an operant training regime in which an animal is trained to use a mirror to guide self-directed responses. Recently, Epstein et al. (1981) reported that they trained pigeons in the use of a mirror to locate and peck at marks on their own bodies which were invisible without the mirror. The pigeons' performances were achieved through a process of shaping, in which the birds learned to respond to blue dots briefly presented at the end of a transparent rod which was pushed through slits in the walls of the test chamber. The birds saw the dot appearing in the mirror, and had to turn and locate the appropriate point in space. They were rewarded with food on a VR 1-5 schedule. The pigeons were

Figure 39. Reactions to a small hand mirror.

Figure 39. Reactions to a small hand mirror.

also trained to peck at dots on areas of their bodies visible without a mirror. The final phase of the study tested the birds with dots on their bodies which they could see in a mirror, but which were not directly visible because of a bib placed around the neck. The birds were observed to aim pecks in the direction of the dots in this condition.

Epstein et al. (1981) propose the exercise described above as a demonstration of an animal using mirrored information to respond to the self, without a need to invoke 'self-awareness' or 'self-recognition'. They suggest that great apes might also simply learn contingencies between mirrored and real space rather than possess self-awareness, and that monkeys might not learn such contingencies because they are more 'mobile'.

The argument by Epstein et al. implies that chimpanzees (and humans?) simply generalize their ability to respond to mirrored space to that region of space which happens to contain their own bodies. No internal representation of self need be involved. Of course the argument is open to criticism on several points. Firstly, some chimpanzees exhibit behaviour suggestive of self-recognition during the first day or two of mirror exposure, rather than after 80 hours as suggested by Epstein et al. Secondly, the nature of the rewards involved in the emergence of a self-directed orientation in great apes would seem obscure, as are the reasons for some apes using mirrors while washing their faces or dressing up.

Therefore although the experiment in 'self-awareness' in the pigeon by Epstein et al. demonstrates a rather superficial analogy to the behaviour of great apes in front of mirrors, it does underline the desirability of critical evaluation of the processes involved in mirror image responses. Gallup (1980) also expressed the caution that would

required in analyzing the behaviour of a monkey trained by operant conditioning to exhibit self-directed behaviours in front of a mirror.

2. Social phenomena suggestive of self-awareness.

A second approach to the question of self-awareness in monkeys would involve careful examination of behaviours to assess the extent of actions which suggest the existence of a concept of self. This may be a difficult task, since even human children who clearly recognize themselves in mirrors may not behave in ways which suggest the development of an advanced self-awareness (e.g., Beaman et al., 1979; Buss, 1980).

One phenomenon which comes to mind in this context is empathy, which is defined by Lewis and Brooks-Gunn (1979) as 'the ability to be able to put oneself in another's place and to image what the other is experiencing' (p. 258). They also state that 'knowledge of both self-other differentiation and self-other similarity is necessary for empathy' (p. 262). Empathy is considered to be very important in much of human social interaction. It permits one person to imagine the emotions, desires, and other thoughts of another. Miley (1980) suggests that empathy makes possible the emergence of 'ultimate altruism', and goes on to argue that pongids for whom objective evidence of self-awareness exists in the form of self-recognition, might also exhibit instances of altruistic behaviour which are not adequately explained by kin selection or reciprocal altruism. Good examples of empathy can be found for great apes (e.g., Hayes, 1952; Hoyt, 1941), and a search for similar examples in monkeys would contribute to our understanding of self-awareness in monkeys. One intriiging report is that by Rowell et al. (1964). Two adult female rhesus monkeys observing another giving birth, reached back and touched their own anogenital regions. More convincing examples are required.

Another behaviour which would strengthen the case for the existence of self-awareness in monkeys is imitation. In their report on imitation of facial and manual gestures in human neonates, Meltzoff and Moore (1977) considered that a neonate imitating a gesture would need to compare 'sensory information from his own unseen motor behavior to a "supramodal" representation of the visually perceived gesture and construct the match required' (p. 78). Such a process would seem to require a fairly sophisticated internal representation of the self. Imitation clearly occurs in home-reared chimpanzees (e.g., Hayes, 1952), and possibly occurs in wild chimpanzees (e.g. McGrew, 1977). However, empirical evidence of imitation in monkeys is scarce, since most potential instances appear to be more parsimoniously explained by other processes, i.e., stimulus enhancement, social facilitation, and observational learning (see Beck, 1975; Clayton, 1978; Hall, 1963). One suggestion would be for an experiment similar to Meltzoff and Moore's (1977) to be carried out with infant monkeys.

The extent to which monkeys are capable of pretence would also bear upon the issue of to what extent monkeys can conceive of themselves. Of course caution is required when reading reports of phenomena which at first glance might seem to imply pretence. Jolly (1972) points out that 'sham feeding' in primates in situations of tension probably reflects the ritualization of feeding activities rather than an instance of 'representative pretense', which presumably involves a representation of self. Accounts of primates approaching and grooming an adult female as a ploy to contact the recipient's body may also tend to overlook the fact that primates also sometimes groom in tense situations (e.g., Simonds, 1974; Terry, 1970).

More compelling examples of 'representative pretense' include role-playing games in home-reared chimpanzees, or cases of 'feigned indifference', for example to avoid drawing the attention of a more dominant chimpanzee to a prized food item (van Lawick-Goodall, 1971). In this context, it is interesting that stumptail macaques exhibit feigned indifference in a variety of situations, such as when they see a piece of food near a dominant male (Bertrand, 1969), or during a mating of other group members, before harassing the mating (Niemeyer, 1980). Jolly (1972) ascribes feigned indifference to the realm of metacommunication, distinct from representative pretence, although the bases for this categorization are not made explicit. Is feigned indifference simply another example of a displacement activity? Further careful accounts of possible cases of pretence, including feigned indifference will be informative.

One particularly noteworthy feature of feigned indifference is that it implies deception, that is the transmission of false information to benefit oneself. Instances of deception are well documented in home-reared pongids (e.g., Hayes, 1952, Hoyt, 1941), and were recently empirically demonstrated in chimpanzees (Woodruff and Premack, 1979). Chimpanzees learned to cooperate in sending information to a human partner who shared the incentive (food) which was obtained on the basis of the information sent by the chimpanzees. However, the chimpanzees learned to give misleading cues to a human who did not share the food. An attempt at such an experiment with monkeys might be worthwhile.

3. Alternative criteria for self recognition.

A more direct approach to the question of self-awareness in monkeys than those suggested in the previous section, would concentrate on visual self-recognition. Lewis and Brooks-Gunn (1979) have convincingly demonstrated that by utilizing sufficiently sophisticated response

measures and stimulus conditions, discrimination of self from nonself can be obtained in human infants in the first year of life. Infants between 9 and 12 months old responded differently to projected pictures of self and other infants. Similar results were obtained using video-taped stimuli (see Section 1.2). The studies of Lewis and Brooks-Gunn have indicated that mark-directed responses is a relatively late-appearing indicator of self-recognition in human infants, compared to other criteria. Yet mirror-guided, mark-directed responding has dominated nonhuman primate studies, as the definitive item of evidence for self-recognition.

Gallup (1977a) has considered the possibility of different degrees of self-awareness, suggesting that the 'threshold' for self-recognition may be high, whereas other criteria for self-awareness might produce different pictures. Of course Gallup's criterion for self-recognition has been mark-directed responding in the mirror-plus-dye test. It would be interesting to see whether other, equally valid forms of evidence for self-recognition would allow monkeys and other organisms to reach the threshold.

A final line of investigation to be suggested here could ask to what extent an animal is aware of its behaviour. An experiment was carried out with rats, which investigated whether rats could use their own behaviours as discriminative cues informing them which of four levers could be pressed at a signal for food reward (Beninger et al., 1974). The rats were successful to a point in discriminating among their own behaviours. Such an experiment does not appear to have been done with monkeys.

In Chapter 1 the central influence of self-conception on human behaviour was considered. The notion of self is seen to be critical to everyday social interaction and personal behaviour (e.g., Buss, 1980; Duval and Wicklund, 1972), to the development of language (Terrace and

Bever, 1976), to empathy (Miley, 1980), and Lewis and Brooks-Gunn (1979) argue that it is essential to the development of emotions. At present reliable evidence for the existence of representative self-awareness in monkeys and nonprimates is very scarce. In contrast the evidence for self-awareness in humans and pongids is stronger, although it requires further investigation. The desirability of intensifying self-awareness research in animals is recognized by several authors (e.g., Desmond, 1979; Gallup, 1977a; Slobodkin, 1980). Gallup (1979) writes 'In principle, once you can conceive of yourself, you can begin to think about yourself. Once you can become the object of your own attention, you can begin to contemplate your own existence' (p. 421). Empirical evidence on the nature of self-awareness in animals not only has philosophical implications, but should also influence our practical relationships with animals.

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APPENDIX ONE. EXAMPLE OF A DTU PAPER TAPE, A RAW DATA PRINTOUT, AND A POD SUMMARY TABLE FOR ONE TAPE

16 NOV 1979 F 70 X DAY 64

CODES END MARK	FREQU	TIME	% TIME	HOLT	101	F PER T	T TIL	T TIL T
							59670	
132000	1	126	0.215	126.	55502.	0.50	46964	
211000	4	726	1.217	182.	14756.	2.01	14034	
212000	35	4874	8.168	139.	1566.	17.60	5502	28190
231000	11	6244	10.551	571.	4853.	5.53	446	21564
232000	22	5024	8.420	228.	2484.	11.06	0	47730
242000	2	166	0.278	83.	29752.	1.01	29006	
251000	7	2466	4.170	355.	8169.	3.52	3866	
312000	4	664	1.113	166.	14752.	2.01	24522	
331000	1	176	0.295	176.	59494.	0.50	57016	
332000	5	652	1.093	130.	11804.	2.51	34548	
351000	9	3504	5.872	389.	6241.	4.52	4018	56512
731000	4	2046	3.429	512.	14406.	2.01	9716	
751000	47	32936	55.200	701.	569.	23.63	616	4522

APPENDIX TWO. DEFINITIONS OF BEHAVIOURAL CATEGORIES

Table 1. Definitions of categories recorded on the home cage checksheet.

Manipulate Environment Manually contacting any aspect of the environment other than diaper or self. Not scored during play or aggression.

Oral Environment Sucking or mouthing any aspect of the environment other than diaper or self. Not scored during play or aggression.

Aggress Environment Threatening, or roughly shaking, grabbing, pulling, pushing or biting any aspect of the environment other than self; often accompanied by threat vocalizations.

Manipulate Self Manually contacting any aspect of the self other than mouth or genitals. Not scored during play or aggression.

Oral Self Sucking or mouthing any aspect of the self other than genitals. Not scored during play or aggression.

Aggress Self Threatening, or roughly shaking, grabbing, pulling, pushing or biting any aspect of the self; often accompanied by threat vocalizations.

Look Diaper Eyes oriented toward the diaper, without manually contacting it, for longer than an estimated .5 seconds. Not scored during play or aggression.

Manipulate Diaper Manually or pedally contacting the diaper. Not scored during clasping of the diaper.

Clasp Diaper Holding the diaper against the self, leaning against it, or lying on it.

Autoeroticism Manually or orally contacting own genitals.

Self-clasp Holding a part of the self, other than genitals, for longer than an estimated .5 seconds. Not scored during play or aggression.

Stereotypy Performing an unusual, repeated movement, e.g., back-flipping, head twisting.

APPENDIX TWO contd.

Bizarre Posture Adopting a posture rarely observed in group-reared animals, e.g., leg(s) held swung over behind the neck, or leg(s) held protruding to the side(s) or upwards.

Walk Common usage. Includes nonplayful running.

Climb Nonplayful locomotion, excluding jumping, which occurs off the cage floor, or which results in the actor leaving the floor, or arriving on it from an elevated position.

Look Observer Eyes oriented toward the observer for longer than an estimated .5 seconds.

Look Environment Eyes oriented toward any aspect of the environment other than observer, diaper, or self, for longer than an estimated .5 seconds, without contacting it. Not scored during play or aggression.

Look Self Eyes oriented toward any aspect of the self for longer than an estimated .5 seconds. Not scored during play or aggression.

Drink Common usage.

Vocalization Any vocalization. Not scored during aggression.

Play (Months 1-3) Nonaggressive activity involving various combinations of running, rolling, leaping, and wrestling, gentle grabbing, pulling, pushing or biting any aspect of the environment; often accompanied by a 'playface'.

Play Environment Same definition as for Play, except that components are directed toward an aspect of the environment. (Months 4-5).

Play Self Components of Play are directed toward an aspect of the self (Months 4-5).

APPENDIX TWO contd.

Table 2. Definitions of categories recorded on the DTU.

Noncontact Submission Fear grimacing, sometimes accompanied by crouching and/or screeching, without contact the object which is the cause of submission.

Contact Submission Same definition as for Noncontact Submission, except that contact is made with the object.

Noncontact Exploration Eyes oriented toward an object, without contacting it, for longer than an estimated .5 seconds.

Contact Exploration Manipulating an object.

Noncontact Play Nonaggressive activity involving various combinations of running, rolling, leaping, often accompanied by a 'playface', but without contacting a specific object, although the eyes may be oriented toward an object.

Contact Play Same definition as for Noncontact Play, and including wrestling, gentle grabbing, pulling, pushing or biting an object.

Noncontact Aggression Threatening an object, and lunging or grabbing at it without contacting it.

Contact Aggression Threatening while contacting, or roughly shaking, grabbing, pulling, pushing or biting an object.

Noncontact Affiliation Lipsmacking or teeth-chattering toward an object without grimacing, or pouting towards it, without contacting it.

Contact Affiliation Grooming an object: contacting it while lipsmacking, teeth-chattering, or pouting; nonaggressive, nonplayful gross bodily contact with an object.[1]

Footnote: It was clear from Day 1 that gross bodily contact could be active, i.e., the subject was responsible for, or helped to maintain contact, or passive, as when the subject was unable to break contact with a clinging partner. Only active bodily contact was scored as Contact Affiliation.

APPENDIX TWO contd.

Noncontact Sex Not scored.

Contact Sex Nonaggressive, nonplayful contact with the partner's genital region, or genital contact with an object.

Noncontact Oral Not scored.

Contact Oral Sucking or mouthing an object other than the genitals.

Noncontact Other The subject's back is to the observer, so the behaviour is not clear, but the subject does not appear to contact an object.

Contact Other Same definition as for Noncontact Other, except that the subject contacts an object. Includes drinking.

APPENDIX THREE. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM HOME CAGE CHECKSHEET ANALYSES

1. Environment- and Self-directed Activity

Source	DF	MS	F	Prob.
Social Partner	1, 4	88.2	0.2	.69
Additional Experience	1, 4	383.1	0.8	.57
Months	4, 16	54.9	0.9	.52
Behaviour	2, 8	50347.0	136.3	.0000
Direction	1, 4	537.7	0.8	.59
Time	1, 4	33.7	6.9	.059
Behaviour X Direction	2, 8	32770.3	31.4	.0002
Months X Direction X Time	4, 16	132.5	4.2	.0165

2. Diaper-directed Activity

Source	DF	MS	F	Prob.
Social Partner	1, 4	6102.4	8.4	.0446
Additional Experience	1, 4	1544.3	2.1	.22
Months	4, 16	237.8	2.2	.11
Behaviour	2, 8	4418.8	11.0	.0053
Social Partner X Behaviour	2, 8	1779.8	4.5	.0500
Time	1, 4	913.4	4.6	.10
Months X Behaviour	8, 32	179.3	2.7	.0200
Social Partner X Behaviour X Time	2, 8	454.0	6.4	.0217

APPENDIX THREE contd. 1. Environment- and Self-directed Activity

Table of Means.

Mirror-Only		Month	1	2	3	4	5
Manipulate	Environment	Weekday	29.9	46.4	39.0	44.8	45.9
		Weekend	34.1	35.8	51.0	41.7	45.6
	Self	W/day	12.0	9.3	12.6	14.6	10.6
		W/end	17.0	17.0	12.9	10.5	12.1
Oral	Environment	W/day	27.7	33.6	20.7	26.2	33.9
		W/end	21.0	26.1	26.5	32.0	27.0
	Self	W/day	33.8	23.4	32.3	41.2	23.7
		W/end	38.8	39.5	24.1	20.7	28.4
Aggress	Environment	W/day	0.2	0.0	0.0	0.4	1.1
		W/end	0.0	0.3	0.3	0.7	0.3
	Self	W/day	0.4	0.0	0.0	0.0	0.4
		W/end	0.3	0.3	1.6	0.0	0.2

Mirror-Perspex							
Manipulate	Environment	Weekday	40.8	41.4	40.9	53.3	46.6
		Weekend	39.1	56.1	45.9	39.3	37.2
	Self	W/day	19.1	22.2	17.3	18.7	16.0
		W/end	22.0	17.3	16.7	20.0	21.4
Oral	Environment	W/day	23.7	27.7	30.6	21.9	10.0
		W/end	24.3	29.0	27.8	17.5	10.0
	Self	W/day	32.1	23.3	26.3	71.0	61.0
		W/end	42.2	38.6	38.4	57.8	59.7
Aggress	Environment	W/day	0.0	0.3	0.4	0.2	0.0
		W/end	0.0	1.1	2.0	0.2	1.4
	Self	W/day	0.4	1.1	0.0	5.2	2.5
		W/end	1.6	0.9	1.2	0.7	1.1

APPENDIX THREE contd. 1. Environment- and Self-directed Activity

Table of Means.

Peer-Only		Month	1	2	3	4	5
Manipulate	Environment	Weekday	53.6	46.9	48.8	55.6	52.8
		Weekend	38.9	41.2	44.1	53.3	53.7
	Self	W/day	9.1	8.2	6.2	2.3	9.4
		W/end	14.4	6.8	7.2	8.2	5.5
Oral	Environment	W/day	21.0	23.1	23.0	31.6	12.5
		W/end	24.8	21.9	18.2	23.8	23.4
	Self	W/day	62.2	51.4	32.0	27.4	36.9
		W/end	69.9	61.4	48.3	36.4	39.9
Aggress	Environment	W/day	0.2	0.8	0.4	1.0	0.7
		W/end	1.2	1.0	0.7	1.7	1.4
	Self	W/day	0.2	0.3	0.2	0.3	1.0
		W/end	0.3	0.3	0.0	1.0	1.2

Peer-Mirror							
Manipulate	Environment	Weekday	42.7	44.2	42.0	47.2	44.7
		Weekend	38.9	36.2	40.0	44.6	42.2
	Self	W/day	4.9	6.9	7.9	9.6	10.6
		W/end	11.2	11.2	7.8	12.7	16.4
Oral	Environment	W/day	11.6	8.7	9.3	5.6	12.9
		W/end	20.0	10.0	15.7	16.4	11.5
	Self	W/day	58.3	60.3	69.0	75.2	59.4
		W/end	53.9	65.8	66.5	60.7	64.1
Aggress	Environment	W/day	0.2	0.5	0.8	0.7	1.9
		W/end	0.0	0.0	0.3	1.6	0.9
	Self	W/day	0.0	0.0	0.2	0.3	0.6
		W/end	0.0	0.3	0.0	2.1	0.4

APPENDIX THREE contd. 2. Diaper-directed Activity

Table of Means.

Mirror-Only	Month	1	2	3	4	5
Look	Weekday	10.6	10.4	11.3	12.6	10.9
	Weekend	15.2	23.4	19.1	13.1	9.8
Manipulate	W/day	9.8	7.8	19.5	22.2	23.9
	W/end	6.4	8.1	16.7	16.9	16.4
Clasp	W/day	3.3	5.2	0.0	1.6	0.3
	W/end	2.2	5.3	2.3	1.2	0.8
Mirror-Perspex						
Look	Weekday	19.1	17.8	13.2	9.0	9.1
	Weekend	16.1	16.8	21.4	15.3	13.6
Manipulate	W/day	24.5	29.1	41.7	16.2	26.0
	W/end	24.8	24.4	37.8	20.6	14.7
Clasp	W/day	15.9	3.3	19.6	0.2	6.6
	W/end	15.2	7.1	16.4	0.6	0.4
Peer-Only						
Look	Weekday	14.4	15.0	17.3	11.2	7.3
	Weekend	23.6	21.0	15.0	13.3	14.7
Manipulate	W/day	13.0	26.9	31.0	22.3	25.7
	W/end	28.2	49.1	54.3	39.4	49.0
Clasp	W/day	6.1	8.7	6.9	7.6	10.0
	W/end	19.5	21.7	24.3	21.8	27.1
Peer-Mirror						
Look	Weekday	12.3	13.0	8.9	8.1	11.9
	Weekend	17.0	13.0	8.2	13.7	10.4
Manipulate	W/day	20.5	30.9	29.5	30.4	35.7
	W/end	29.1	43.2	39.1	33.4	41.5
Clasp	W/day	21.6	31.2	36.4	36.0	29.1
	W/end	15.7	31.6	32.3	33.7	36.7

APPENDIX THREE contd. 3. Locomotion and Vocalization.

Locomotion: Source	DF	MS	F	Prob
Social Partner	1, 4	19.3	0.0	.38
Additional Experience	1, 4	47.4	0.1	.82
Months	4, 16	559.6	5.5	.0057
Additional Experience X Months	4, 16	563.3	5.5	.0056
Behaviour	1, 4	1742.3	6.7	.06
Time	1, 4	156.7	19.5	.0128
Social Partner X Behaviour X Time	1, 4	1008.9	38.7	.0045
Social Partner X Months X Behaviour X Time	4, 16	100.1	7.7	.0012

Vocalization: Source	DF	MS	F	Prob.
Social Partner	1, 4	1500.8	0.9	.60
Additional Experience	1, 4	532.0	0.3	.61
Months	4, 16	612.6	5.7	.0049
Time	1, 4	5361.2	38.1	.0046
Social Partner X Time	1, 4	3536.5	25.1	.0087

APPENDIX THREE contd. 3. Locomotion and Vocalization

Table of Means. Locomotion:

Mirror-Only	Month	1	2	3	4	5
Walk	Weekday	36.5	43.0	53.5	53.3	55.3
	Weekend	27.8	36.1	54.2	52.3	47.5
Climb	W/day	24.4	35.0	40.8	39.9	43.3
	W/end	27.8	33.6	49.5	55.4	57.5
Mirror-Perspex						
Walk	Weekday	47.5	60.4	49.4	42.3	39.7
	Weekend	38.1	49.6	52.3	45.3	35.7
Climb	W/day	48.0	72.1	68.4	52.6	36.9
	W/end	53.4	57.9	67.0	61.7	62.5
Peer-Only						
Walk	Weekday	30.0	40.2	45.7	50.9	49.4
	Weekend	47.3	46.0	48.2	47.3	53.4
Climb	W/day	42.9	56.9	56.3	65.9	64.1
	W/end	61.4	55.3	56.9	55.7	58.3
Peer-Mirror						
Walk	Weekday	34.7	41.1	34.6	31.0	39.7
	Weekend	45.9	45.5	41.9	49.3	47.3
Climb	W/day	48.3	50.6	57.9	46.5	52.9
	W/end	42.1	49.5	58.6	45.5	40.2
Vocalization:						
Mirror-Only	Weekday	8.2	17.3	21.1	18.0	12.2
	Weekend	13.9	18.6	25.9	19.4	14.2
Mirror-Perspex	Weekday	47.1	43.6	55.3	19.9	28.5
	Weekend	56.7	53.4	45.9	20.3	28.6
Peer-Only	Weekday	18.1	39.2	25.2	25.5	25.1
	Weekend	49.5	67.7	68.3	57.9	57.3
Peer-Mirror	Weekday	18.6	25.7	20.0	15.4	11.9
	Weekend	30.2	52.3	53.2	45.0	38.6

APPENDIX THREE contd. 4. Play Activity

Months 1-3:

Source	DF	MS	F	Prob.
Social Partner	1, 4	117.8	0.2	.66
Additional Experience	1, 4	727.0	1.4	.31
Months	2, 8	2533.8	64.6	.0000
Social Partner X Additional Experience X Months	2, 8	205.7	5.3	.0349
Time	1, 4	35.0	0.2	.66

Months 4-5:

Source	DF	MS	F	Prob.
Social Partner	1, 4	157.5	0.5	.52
Additional Experience	1, 4	1051.4	3.4	.14
Months	1, 4	15.0	0.2	.67
Direction	1, 4	16867.5	66.4	.0021
Time	1, 4	7.0	0.7	.55
Social Partner X Time	1, 4	467.6	48.0	.0033
Social Partner X Direction X Time	1, 4	401.0	10.3	.0333

APPENDIX THREE contd. 4. Play Activity

Table of Means. Months 1-3:

	Month	1	2	3	4	5
Mirror-Only	Weekday	46.6	58.3	55.0		
	Weekend	34.2	50.3	56.2		
Mirror-Perspex	Weekday	19.2	53.1	52.5		
	Weekend	24.7	48.8	47.5		
Peer-Only	Weekday	24.6	55.2	55.0		
	Weekend	32.3	50.7	56.0		
Peer-Mirror	Weekday	26.9	40.7	50.8		
	Weekend	28.4	36.8	51.6		

Months 4-5:

Mirror-Only	Environment	Weekday	38.7	49.7
		Weekend	46.1	50.5
	Self	W/day	11.7	14.2
		W/end	14.8	15.3
Mirror-Perspex	Environment	Weekday	26.5	31.3
		Weekend	42.9	46.8
	Self	W/day	13.1	10.4
		W/end	11.8	10.4
Peer-Only	Environment	Weekday	53.4	62.8
		Weekend	46.9	53.4
	Self	W/day	22.3	18.5
		W/end	17.0	13.8
Peer-Mirror	Environment	Weekday	51.7	49.4
		Weekend	40.0	33.3
	Self	W/day	5.2	5.8
		W/end	9.4	6.1

APPENDIX THREE cont'd. 3. The 'Isolation Syndrome'

Table of Means.

		Month	1	2	3	4	5
Mirror-Only							
	Autoeroticism	Weekday	17.1	12.2	8.8	11.0	8.2
		Weekend	17.7	17.0	9.5	12.2	12.0
	Self-clasp	M/day	0.3	1.9	3.5	0.3	0.9
		M/end	0.7	4.5	1.6	1.7	0.7
	Stereotypy	M/day	0.0	0.0	0.0	0.0	0.4
		M/end	0.0	0.0	0.4	0.0	0.0
	Bizarre Posture	M/day	1.8	1.6	1.4	1.1	3.4
		M/end	2.6	3.1	0.2	3.1	1.9
Mirror-Perspex							
	Autoeroticism	Weekday	2.1	0.3	0.2	0.7	0.0
		Weekend	0.9	0.0	0.0	0.4	0.4
	Self-clasp	M/day	3.7	3.4	2.3	0.7	2.5
		M/end	2.0	1.9	0.9	1.4	4.0
	Stereotypy	M/day	0.2	3.4	0.2	0.2	5.7
		M/end	0.6	1.9	1.2	1.6	4.7
	Bizarre Posture	M/day	9.2	7.3	8.2	13.5	15.3
		M/end	11.1	11.7	6.7	11.0	6.5
Peer-Only		Weekday	1.3	2.7	0.3	0.4	2.9
	Autoeroticism	Weekend	1.9	1.3	0.3	2.4	1.1
	Self-clasp	M/day	0.0	1.5	0.3	0.0	0.7
		M/end	1.6	3.7	3.1	0.6	1.6
	Stereotypy	M/day	0.0	0.2	0.0	2.1	1.6
		M/end	0.7	0.0	0.0	4.7	2.2
	Bizarre Posture	M/day	0.5	2.2	0.9	0.0	2.3
		M/end	1.2	1.3	5.6	2.7	2.4

APPENDIX THREE contd. 5. The 'Isolation Syndrome'

Table of Means.

Peer-Mirror		Month	1	2	3	4	5
	Autoeroticism	Weekday	1.0	3.6	2.1	6.4	4.1
		Weekend	2.8	3.7	5.3	8.9	10.0
	Self-clasp	W/day	0.0	1.2	0.7	2.5	7.5
		W/end	0.3	0.0	0.3	4.6	5.4
	Stereotypy	W/day	0.0	0.0	0.0	0.0	1.0
		W/end	0.5	0.0	0.0	0.0	0.7
	Bizarre Posture	W/day	0.5	2.7	3.3	4.9	8.5
		W/end	2.5	5.5	1.8	5.9	7.2

6. Self-looking, Drinking, and Scratching

Table of Means Lock Self:

Mirror-Only	Month	1	2	3	4	5
	Weekday	9.5	5.0	5.3	9.3	8.4
	Weekend	14.1	10.6	4.7	12.4	9.7
Mirror-Perspex	Weekday	12.3	6.7	10.4	10.0	13.3
	Weekend	7.7	5.1	7.3	9.1	7.5
Peer-Only	Weekday	3.3	3.4	4.0	5.1	6.0
	Weekend	5.3	5.3	4.6	9.6	3.3
Peer-Mirror	Weekday	3.9	2.6	3.5	4.2	4.7
	Weekend	3.5	5.2	4.0	7.1	6.7

APPENDIX THREE contd. 5. The 'Isolation Syndrome'

Source	DF	MS	F	Prob.
Social Partner	1, 4	239.3	3.9	.12
Additional Experience	1, 4	23.4	0.4	.58
Months	4, 16	29.4	4.7	.0108
Social Partner X Months	4, 16	26.2	4.1	.0165
Additional Experience X Months	4, 16	28.4	4.5	.0122
Behaviour	3, 12	310.6	3.6	.0465
Additional Experiance X Behaviour	3, 12	304.4	5.1	.0490
Social Partner X Additional Experiance X Behaviour	3, 12	443.5	5.1	.0166
Time	1, 4	16.2	3.5	.13

6. Self-looking, Drinking, and Scratching

Look Self:

Source	DF	MS	F	Prob.
Social Partner	1, 4	344.3	3.5	.14
Additional Experience	1, 4	1.4	0.0	.91
Months	4, 16	23.5	1.7	.21
Time	1, 4	7.4	0.5	.51

APPENDIX THREE contd. 6. Self-looking, Drinking, and Scratching.

Drink:

Source	DF	MS	F	Prob.
Social Partner	1, 4	14.5	0.3	.61
Additional Experience	1, 4	28.7	0.6	.52
Months	4, 16	26.3	1.2	.37
Time	1, 4	3.8	1.7	.27
Social Partner X Time	1, 4	24.3	10.5	.0323

Scratch:

Social Partner	1, 4	25.1	0.9	.60
Additional Experience	1, 4	67.3	2.4	.20
Months	4, 16	30.7	1.2	.34
Time	1, 4	11.1	1.5	.30
Social Partner X Time	1, 4	97.2	12.7	.0245
Social Partner X Additional Experience X Time	1, 4	71.4	9.3	.0385
Social Partner X Additional Experience X Months X Time	4, 16	27.7	3.5	.0315

APPENDIX THREE contd. 6. Self-looking, Drinking, and Scratching

Table of Means.

Drink:	Month	1	2	3	4	5
Mirror-Only	Weekday	12.1	8.1	8.1	2.9	4.8
	Weekend	12.3	8.3	4.9	7.2	4.5
Mirror-Perspex	Weekday	2.8	3.5	10.0	0.7	2.5
	Weekend	5.9	7.8	4.7	7.0	8.3
Peer-Only	Weekday	7.9	4.2	6.6	7.8	2.2
	Weekend	6.1	5.3	3.5	2.8	10.3
Peer-Mirror	Weekday	9.5	5.7	7.8	3.8	2.5
	Weekend	5.5	3.1	5.7	3.0	6.0
Scratch:						
Mirror-Only	Weekday	5.6	4.6	5.3	8.6	6.4
	Weekend	9.3	2.5	2.4	5.5	8.0
Mirror-Perspex	Weekday	11.2	10.8	5.9	10.7	6.0
	Weekend	11.1	4.8	5.9	6.2	4.3
Peer-Only	Weekday	9.3	8.1	4.1	3.2	9.7
	Weekend	5.0	3.6	11.0	8.5	7.0
Peer-Mirror	Weekday	7.5	5.9	3.7	10.5	2.2
	Weekend	15.9	11.2	9.3	10.7	11.4

APPENDIX FOUR. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM HOME CAGE DTU ANALYSES. 1. WEEKDAY OBSERVATIONS

1. Exploration (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	179.1	9.0	.0238
Months	4, 24	1.5	0.1	.98
Form	1, 6	2523.8	155.8	.0001

(ii) Percentage of time

Social Partner	1, 6	32.6	3.6	.11
Months	4, 24	16.0	3.1	.0357
Form	1, 6	733.3	136.3	.0001

(iii) Bout length

Social Partner	1, 6	0.7	0.3	.59
Months	4, 24	3.8	9.3	.0001
Form	1, 6	1.6	3.1	.13

2. Aggression (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	0.1	2.2	.18
Months	4, 24	0.1	2.1	.12
Social Partner X Months	4, 24	0.2	4.3	.0094
Form	1, 6	0.1	3.5	.11

(ii) Percentage of time

Social Partner	1, 6	0.0	0.0	.99
Months	4, 24	0.0	0.8	.56
Form	1, 6	0.1	3.3	.12

APPENDIX FOUR contd. 1. Exploration

Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-reared	Contact	3.2	2.5	4.3	3.0	0.9
	Noncontact	12.4	13.6	11.1	12.7	11.3
Peer-reared	Contact	5.3	4.0	3.1	3.3	4.1
	Noncontact	14.4	16.7	16.0	18.4	19.4

(ii) Percentage of time

Mirror-reared	Contact	3.6	1.8	2.9	2.3	0.5
	Noncontact	9.7	7.8	6.7	8.3	5.7
Peer-reared	Contact	4.9	3.2	1.7	2.0	2.6
	Noncontact	10.7	9.5	9.3	8.8	9.4

(iii) Bout length

Mirror-reared	Contact	3.5	2.1	2.0	1.9	1.4
	Noncontact	2.6	2.0	2.0	1.9	1.5
Peer-reared	Contact	2.9	2.3	1.6	1.8	1.8
	Noncontact	2.2	1.7	1.7	1.4	1.5

2. Aggression

Table of Means (i) Rate

Mirror-reared	Contact	.21	.13	.03	.20	.00
	Noncontact	.08	.00	.06	.02	.00
Peer-reared	Contact	.00	.07	.07	.19	.52
	Noncontact	.02	.03	.00	.27	.27

(ii) Percentage of time

Mirror-reared	Contact	.38	.05	.01	.16	.00
	Noncontact	.08	.00	.02	.01	.00
Peer-reared	Contact	.00	.03	.03	.13	.31
	Noncontact	.01	.01	.00	.11	.09

APPENDIX FOUR contd. 3. Play

(i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	275.1	18.2	.0056
Months	4, 24	6.6	0.6	.70
Form	1, 6	79.8	28.6	.0020
Months X Form	4, 24	10.9	5.3	.0034

(ii) Percentage of time

Social Partner	1, 6	166.2	8.2	.0283
Months	4, 24	5.3	0.6	.65
Form	1, 6	2.7	0.5	.50
Social Partner X Form	1, 6	59.3	11.5	.0146
Months X Form	4, 24	9.5	3.5	.0215

(iii) Bout length

Social Partner	1, 6	0.3	0.1	.79
Months	4, 24	2.6	7.3	.0006
Form	1, 6	5.2	9.9	.0198
Social Partner X Form	1, 6	3.9	7.4	.0341

4. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	0.0	0.0	.96
Months	4, 24	0.4	1.1	.36
Form	1, 6	12.0	32.1	.0016

(ii) Percentage of time

Social Partner	1, 6	3.9	0.3	.60
Months	4, 24	12.5	1.5	.25
Form	1, 6	125.3	10.9	.0164

APPENDIX FOUR contd. 3. Play

Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-reared	Contact	2.6	2.8	2.7	2.1	1.2
	Noncontact	3.7	5.3	4.4	5.6	6.0
Peer-reared	Contact	6.4	6.1	9.3	5.8	6.0
	Noncontact	5.4	7.7	8.9	9.0	8.9

(ii) Percentage of time

Mirror-reared	Contact	2.7	3.1	2.2	1.7	0.8
	Noncontact	3.0	4.0	3.6	3.5	3.2
Peer-reared	Contact	9.0	6.4	8.3	4.1	5.7
	Noncontact	3.5	4.7	5.1	4.9	4.9

(iii) Bout length

Mirror-reared	Contact	2.6	2.8	2.2	2.0	1.5
	Noncontact	2.7	2.5	2.3	1.7	1.5
Peer-reared	Contact	3.7	3.2	2.4	2.0	2.6
	Noncontact	1.8	1.7	2.2	1.6	1.7

4. Affiliation (i) Rate

Mirror-reared	Contact	1.3	1.0	0.7	1.0	0.3
	Noncontact	0.1	0.1	0.4	0.1	0.1
Peer-reared	Contact	1.2	0.8	1.3	0.9	0.5
	Noncontact	0.0	0.0	0.0	0.1	0.1

(ii) Percentage of time

Mirror-reared	Contact	3.4	3.7	1.5	1.8	0.1
	Noncontact	0.1	0.1	0.4	0.0	0.1
Peer-reared	Contact	7.2	2.8	2.5	2.1	0.8
	Noncontact	0.0	0.0	0.0	0.0	0.1

APPENDIX FOUR contd. 5. Total Responsiveness

(i) Rate Source	DF	MS	F	Prob.
Social Partner	1, 6	917.7	32.3	.0015
Months	4, 24	6.6	0.1	.97
Form	1, 6	3075.S	144.0	.0001
(ii) Percentage of time				
Social Partner	1, 6	421.0	10.1	.0189
Months	4, 24	79.7	4.5	.0073
Form	1, 6	197.7	18.7	.0053
(iii) Bout length				
Social Partner	1, 6	0.2	0.1	.82
Months	4, 24	10.8	6.8	.0009
Form	1, 6	43.5	12.2	.0130
Months X Form	4, 24	4.8	3.2	.0303

Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-reared	Contact	7.3	6.2	7.7	6.3	2.3
	Noncontact	16.2	19.0	16.0	13.4	17.4
Peer-reared	Contact	12.8	10.9	13.7	10.2	11.1
	Noncontact	19.9	24.5	24.9	27.3	23.7
(ii) Percentage of time						
Mirror-reared	Contact	10.1	9.7	8.3	5.7	1.3
	Noncontact	12.3	11.9	10.7	11.3	9.0
Peer-reared	Contact	21.1	12.4	12.5	8.3	9.2
	Noncontact	14.2	14.2	14.4	13.9	14.7
(iii) Bout length						
Mirror-reared	Contact	3.9	5.2	3.0	2.6	1.5
	Noncontact	2.9	2.1	2.1	1.7	1.5
Peer-reared	Contact	3.3	4.2	2.7	2.1	2.3
	Noncontact	1.9	1.6	2.0	1.4	1.4

APPENDIX FOUR contd. 6. Within-Month Variability (Standard Deviations).

Exploration:
(i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	8.8	1.1	.35
Moths	4, 24	13.2	2.7	.0546
Form	1, 6	258.5	65.4	.0003
(ii) Percentage of time				
Social Partner	1, 6	0.6	0.1	.76
Months	4, 24	19.9	9.6	.0001
Form	1, 6	109.9	27.9	.0021
(iii) Bout length				
Social Partner	1, 6	0.5	0.6	.51
Months	3, 18	2.3	2.9	.07
Form	1, 6	4.4	4.7	.07

Play: (i) Rate

Social Partner	1, 6	34.6	13.0	.0114
Months	4, 24	0.9	0.2	.92
Form	1, 6	11.5	24.4	.0029
Social Partner X Form	1, 6	8.7	18.4	.0055
Months X Form	4, 24	5.0	7.0	.0008
(ii) Percentage of time				
Social Partner	1, 6	57.7	6.7	.0410
Months	4, 24	7.4	1.4	.26
Form	1, 6	25.6	5.3	.06
Social Partner X Form	1, 6	57.9	11.8	.0139
(iii) Bout length				
Social Partner	1, 6	0.5	0.7	.57
Months	3, 18	0.6	1.1	.39
Form	1, 6	2.9	4.7	.07

APPENDIX FOUR contd. 6. Within-Month Variability (Standard Deviations).

Table of Means Exploration: (i) Rate

	Month	1	2	3	4	5
Mirror-reared	Contact	2.8	1.8	2.5	1.8	0.8
	Noncontact	5.6	4.2	6.2	5.6	3.9
Peer-reared	Contact	2.7	2.2	1.8	2.0	2.1
	Noncontact	7.7	5.0	8.9	5.3	4.2
(ii) Percentage of time						
Mirror-rered	Contact	4.0	1.5	2.0	1.8	0.5
	Noncontact	6.1	2.5	3.9	4.6	2.8
Peer-reared	Contact	2.6	2.1	1.2	1.2	2.0
	Noncontact	6.8	3.7	6.2	3.0	2.7
(iii) Bout length						
Mirror-reared	Contact	2.6	0.5	0.9	0.7	
	Noncontact	1.0	0.4	0.7	0.4	
Peer-reared	Contact	1.2	1.1	0.6	0.9	
	Noncontact	0.7	0.4	0.5	0.2	
Play: (i) Rate						
Mirror-reared	Contact	2.2	1.3	2.2	1.5	0.9
	Noncontact	2.8	3.6	2.7	2.6	3.6
Peer-reared	Contact	4.0	3.0	5.1	3.4	2.6
	Noncontact	3.5	4.3	3.2	3.9	3.7
(ii) Percentage of time						
Mirror-reared	Contact	2.6	1.9	2.2	1.2	0.6
	Noncontact	2.1	2.6	2.6	2.2	1.3
Peer-reared	Contact	7.9	4.1	5.8	2.9	4.7
	Noncontact	2.8	2.9	1.4	2.5	1.7
(iii) Bout length						
Mirror-reared	Contact	0.8	1.1	0.8	0.7	
	Noncontact	0.8	0.8	0.5	0.4	
Peer-reared	Contact	1.9	1.4	1.0	0.6	
	Noncontact	0.4	0.3	1.1	0.5	

APPENDIX FOUR contd. 7. Within-Day Bout Length Variability (Standard Deviations).

Exploration:

Source	DF	MS	F	Prob.
Social Partner	1, 6	0.7	1.4	.28
Months	4, 24	0.7	0.9	.50
Form	1, 6	0.5	0.3	.59

Play:

Social Partner	1, 6	4.3	1.5	.26
Months	4, 24	1.3	1.9	.15
Form	1, 6	16.3	39.9	.0009
Social Partner X Form	1, 6	4.3	10.5	.0176

Table of Means. Exploration:

	Month	1	2	3	4	5
Mirror-reared	Contact	1.6	1.3	0.6	1.7	1.0
	Noncontact	1.7	1.4	1.1	1.3	0.8
Peer-reared	Contact	1.1	2.2	0.9	0.9	1.3
	Noncontact	1.9	1.3	2.6	1.0	1.2

Play:

Mirror-reared	Contact	2.4	1.8	1.5	1.0	0.7
	Noncontact	1.1	1.1	1.3	0.9	0.7
Peer-reared	Contact	2.8	2.5	2.2	1.7	2.9
	Noncontact	1.4	1.1	0.8	1.1	0.9

APPENDIX FIVE. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM HOME CAGE DTU ANALYSES. 2. WEEKDAY-WEEKEND COMPARISONS

1. Comparisons among Pairs in Mirror-directed Activity.

1. Exploration (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	17.1	3.3	.17
Months	4, 12	6.6	0.6	.67
Form	1, 3	1494.5	125.2	.0010
Pair X Months X Form	8, 12	17.1	3.4	.028S

(ii) Percentage of time

Pair	2, 3	0.6	0.2	.36
Months	4, 12	14.8	2.6	.09
Form	1, 3	444.2	148.6	.0008

(iii) Bout length

Pair	2, 3	4.1	2.2	.26
Months	4, 12	2.6	8.5	.0019
Pair X Months	8, 12	1.0	3.3	.0316
Form	1, 3	1.3	2.7	.20

2. Aggression. (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	0.0	0.5	.66
Months	4, 12	0.1	3.2	.06
Form	1, 3	0.1	4.1	.13

APPENDIX FIVE contd. 2.. Aggression (ii) Percentage of time

Source	DF	MS	F	Prob.
Pair	2, 3	0.0	0.4	.71
Months	4, 12	0.1	1.4	.29
Form	1, 3	0.1	2.5	.21

3. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	0.4	0.4	.69
Months	4, 12	0.3	0.9	.52
Form	1, 3	8.3	10.7	.0454

(ii) Percentage of time

Pair	2, 3	3.6	0.9	.51
Months	4, 12	1.3	1.0	.44
Form	1, 3	58.5	18.1	.0222

4. Play (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	16.9	6.0	.09
Months	4, 12	4.8	1.0	.43
Form	1, 3	124.5	34.7	.0083

APPENDIX FIVE contd. 4. Play (ii) Percentage of time

Source	DF	MS	F	Prob.
Pair	2, 3	41.4	48.8	.0046
Months	4, 12	7.4	2.9	.07
Form	1, 3	32.4	19.6	.0198
Pair X Months X Form	8, 12	1.7	3.7	.0211

(iii) Bout length

Pair	2, 3	12.8	13.4	.0315
Months	4, 12	1.8	15.4	.0001
Pair X Months	8, 12	0.6	5.3	.0056
Form	1, 3	0.1	1.6	.30
Pair X Months X Form	8, 12	0.2	3.3	.0312

5. Total Responsiveness (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	10.5	0.9	.51
Months	4, 12	24.6	0.8	.55
Form	1, 3	2170.2	84.2	.0020

(ii) Percentage of time

Pair	2, 3	30.8	25.5	.0125
Months	4, 12	43.8	3.6	.0378
Form	1, 3	351.2	25.7	.0132

(iii) Bout length

Pair	2, 3	0.7	0.5	.66
Months	4, 12	7.4	3.3	.0469
Pair X Months	8, 12	6.5	2.9	.0459
Form	1, 3	4.1	0.2	.67

APPENDIX FIVE contd. 1. Comparisons among Pairs in Mirror-directed Activity.

1. Exploration. Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-Only	Contact	3.1	2.5	3.8	4.4	1.3
	Noncontact	6.6	7.4	9.3	13.8	14.5
Mirror-Perspex	Contact	3.2	2.4	4.8	1.7	0.5
	Noncontact	18.2	19.8	12.9	11.6	8.0
Peer-Mirror	Contact	4.0	3.3	3.1	1.7	1.2
	Noncontact	13.9	12.5	15.3	13.9	13.1

(ii) Percentage of time

Mirror-Only	Contact	5.1	2.1	3.3	3.7	0.8
	Noncontact	6.8	5.5	6.2	9.7	7.8
Mirror-Perspex	Contact	2.2	1.5	2.5	0.9	0.2
	Noncontact	12.6	10.2	7.2	6.9	3.7
Peer-Mirror	Contact	3.7	2.1	1.8	1.0	1.7
	Noncontact	9.2	6.5	8.2	7.2	6.6

(iii) Bout length

Mirror-Only	Contact	5.2	2.5	2.5	2.4	1.6
	Noncontact	3.1	2.4	2.1	2.0	1.6
Mirror-Perspex	Contact	1.9	1.7	1.4	1.4	1.3
	Noncontact	2.1	1.7	1.9	1.7	1.4
Peer-Mirror	Contact	2.8	1.9	1.6	1.7	2.9
	Noncontact	2.0	1.5	1.6	1.5	1.6

2. Aggression. (i) Rate

	Month	1	2	3	4	5
Mirror-Only	Contact	0.5	0.0	0.0	0.3	0.0
	Noncontact	0.2	0.0	0.0	0.0	0.0
Mirror-Perspex	Contact	0.0	0.3	0.1	0.1	0.0
	Noncontact	0.0	0.0	0.1	0.0	0.0
Peer-Mirror	Contact	0.1	0.0	0.1	0.9	0.0
	Noncontact	0.1	0.0	0.0	0.3	0.0

APPENDIX FIVE contd. 2. Aggression. Table of Means (ii) Percentage of time

	Month	1	2	3	4	5
Mirror-Only	Contact	0.8	0.00	0.0	0.2	0.0
	Noncontact	0.2	0.0	0.0	0.0	0.0
Mirror-Perspex	Contact	0.0	0.1	0.0	0.1	0.0
	Noncontact	0.0	0.0	0.1	0.0	0.0
Peer-Mirror	Contact	0.0	0.0	0.0	0.6	0.0
	Noncontact	0.0	0.0	0.0	0.2	0.0

3. Affiliation.

Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-Only	Contact	0.8	0.4	0.9	1.1	0.1
	Noncontact	0.0	0.0	0.1	0.0	0.0
Mirror-Perspex	Contact	1.9	1.6	0.4	0.8	0.4
	Noncontact	0.1	0.2	0.8	0.1	0.3
Peer-Mirror	Contact	0.4	0.7	2.0	1.2	0.6
	Noncontact	0.0	0.1	0.0	0.1	0.2

(ii) Percentage of time

Mirror-Only	Contact	1.5	0.9	1.5	2.8	0.1
	Noncontact	0.1	0.0	0.1	0.0	0.0
Mirror-Perspex	Contact	5.3	6.5	1.5	0.3	0.2
	Noncontact	0.1	0.1	0.3	0.1	0.1
Peer-Mirror	Contact	0.8	2.1	2.4	2.2	2.9
	Noncontact	0.1	0.1	0.0	0.1	0.2

4. Play Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-Only	Contact	3.3	3.6	3.5	3.6	1.7
	Noncontact	3.3	5.2	5.3	6.9	8.3
Mirror-Perspex	Contact	2.0	1.9	1.9	0.6	0.3
	Noncontact	4.0	5.3	3.5	4.2	3.2
Peer-Mirror	Contact	3.3	4.3	2.9	1.1	0.6
	Noncontact	5.8	7.6	7.1	5.2	2.6

APPENDIX FIVE contd. 4. Play Table of Means (ii) Percentage of time

	Month	1	2	3	4	5
Mirror-Only	Contact	4.4	5.3	3.4	3.2	1.2
	Noncontact	3.9	4.9	5.4	5.2	5.0
Mirror-Perspex	Contact	0.9	0.9	1.0	0.3	0.3
	Noncontact	2.0	3.2	1.7	1.8	1.3
Peer-Mirror	Contact	2.5	3.0	1.6	0.6	0.5
	Noncontact	3.9	4.9	3.9	2.5	1.3

(iii) Bout length

Mirror-Only	Contact	3.8	4.3	2.8	2.9	1.7
	Noncontact	3.6	3.1	3.2	2.2	1.7
Mirror-Perspex	Contact	1.4	1.3	1.6	1.2	1.3
	Noncontact	1.7	2.0	1.4	1.3	1.2
Peer-Mirror	Contact	1.9	1.9	1.7	1.6	1.7
	Noncontact	1.9	1.9	1.6	1.5	1.5

5. Total Responsiveness. Table of Means (i) Rate

	Month	1	2	3	4	5
Mirror-Only	Contact	7.6	6.5	8.2	9.4	3.1
	Noncontact	10.1	12.6	14.7	20.8	23.3
Mirror-Perspex	Contact	7.1	6.1	7.2	3.1	1.6
	Noncontact	22.3	25,3	17.3	16.0	11.5
Peer-Mirror	Contact	7.8	8.3	8.1	5.0	2.4
	Noncontact	19.7	20.2	22.5	19.5	15.9

(ii) Percentage of time

Mirror-Only	Contact	11.7	8.4	8.2	9.9	2.1
	Noncontact	11.0	10.4	11.7	14.8	12.8
Mirror-Perspex	Contact	8.4	9.0	5.0	2.0	0.8
	Noncontact	14.7	13.5	9.7	8.8	5.1
Peer-Mirror	Contact	7.0	7.2	5.7	4.4	5.1
	Noncontact	13.3	11.4	12.1	9.9	8.1

APPENDIX FIVE contd. 5. Total Responsiveness. Table of Means

(iii) Bout length

	Month	1	2	3	4	5
Mirror-Only	Contact	4.2	3.8	3.1	3.4	1.7
	Noncontact	3.6	2.6	2.7	2.1	1.6
Mirror-Perspex	Contact	3.4	6.4	2.5	1.1	0.8
	Noncontact	4.7	5.2	2.6	2.5	2.1
Peer-Mirror	Contact	2.9	3.3	1.9	2.1	6.9
	Noncontact	3.2	1.8	1.7	1.5	2.1

2. Comparisons among Pairs in Peer-directed Activity.

1. Exploration (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	36.8	1.3	.39
Months	4, 12	2.7	0.3	.88
Form	1, 3	2436.7	326.6	.0002

(ii) Percentage of time

Pair	2, 3	27.4	2.2	.26
Months	4, 12	4.8	2.5	.10
Form	1, 3	607.3	509.2	.0001

(iii) Bout length

Pair	2, 3	0.2	2.7	.22
Months	4, 12	0.7	3.5	.0424
Form	1, 3	3.1	15.7	.0272
Pair X Months X Form	8, 12	0.4	5.8	.0039

APPENDIX FIVE contd. 2. Aggression (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	0.1	8.3	.06
Months	4, 12	0.1	5.9	.0075
Form	1, 3	0.0	1.8	.27

(ii) Percentage of time

Pair	2, 3	0.0	11.0	.0413
Months	4, 12	0.0	5.4	.0103
Form	1, 3	0.0	17.8	.0226

3. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	0.4	0.5	.64
Months	4, 12	0.2	0.8	.55
Form	1, 3	6.2	9.8	.0509

(ii) Percentage of time

Pair	2, 3	11.7	0.6	.61
Months	4, 12	7.8	0.9	.52
Form	1, 3	70.4	3.7	.15

4. Play (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	253.5	22.4	.0151
Months	4, 12	7.8	0.5	.74
Form	1, 3	29.2	15.7	.0271

APPENDIX FIVE contd. 4. Play (ii) Percentage of time

Source	DF	MS	F	Prob.
Pair	2, 3	173.3	26.5	.0118
Months	4, 12	4.7	0.4	.78
Form	1, 3	20.4	9.3	.054
Pair X Form	2, 3	22.5	10.3	.0455

(iii) Bout length

Pair	2, 3	0.5	6.0	.09
Form	1, 3	1.8	14.1	.0316

5. Total Responsiveness. (i) Rate

Source	DF	MS	F	Prob.
Pair	2, 3	504.8	10.3	.0451
Months	4, 12	16.2	0.4	.79
Form	1, 3	2715.4	314.1	.0002

(ii) Percentage of time

Pair	2, 3	415.7	6.7	.08
Months	4, 12	37.9	3.5	.0410
Form	1, 3	136.8	19.4	.0201

(iii) Bout length

Pair	2, 3	1.3	0.4	.73
Months	4, 12	3.9	2.6	.09
Form	1, 3	37.4	8.6	.06

APPENDIX FIVE contd. 2. Comparisons among Pairs in Peer-directed Activity.

1. Exploration. Table of Means (i) Rate

	Month	1	2	3	4	5
Peer-Only	Contact	5.4	4.0	3.0	2.6	3.6
	Noncontact	13.5	13.2	17.6	18.5	20.2
Peer-Mirror	Contact	5.2	4.0	3.1	4.1	4.6
	Noncontact	15.4	20.2	14.4	18.3	18.7
Mirror-Perspex	Contact	0.4	2.6	3.7	1.8	1.9
	Noncontact	13.8	15.0	16.4	14.3	12.0

(ii) Percentage of time

Peer-Only	Contact	4.5	3.5	1.5	1.4	2.5
	Noncontact	9.1	6.7	8.9	9.1	9.4
Peer-Mirror	Contact	5.4	2.9	1.8	2.6	2.8
	Noncontact	12.4	12.3	9.8	8.6	9.5
Mirror-Perspex	Contact	0.3	1.7	2.4	1.7	2.0
	Noncontact	8.4	7.9	7.9	6.8	5.8

(iii) Bout length

Peer-Only	Contact	2.7	2.6	1.5	1.7	1.7
	Noncontact	2.0	1.5	1.5	1.5	1.4
Peer-Mirror	Contact	3.1	2.1	1.7	2.0	1.9
	Noncontact	2.3	1.9	2.0	1.4	1.6
Mirror-Perspex	Contact	1.8	1.8	2.0	2.7	2.9
	Noncontact	1.8	2.0	1.4	1.4	1.5

2. Aggression (i) Rate

	Month	1	2	3	4	5
Peer-Only	Contact	0.0	0.2	0.0	0.2	0.3
	Noncontact	0.0	0.0	0.0	0.2	0.3
Peer-Mirror	Contact	0.0	0.0	0.1	0.2	0.3
	Noncontact	0.0	0.1	0.0	0.4	0.3
Mirror-Perspex	Contact	0.0	0.0	0.2	0.1	0.0
	Noncontact	0.0	0.0	0.1	0.0	0.0

APPENDIX FIVE contd. 2. Aggression Table of Means (ii) Percentage of time

	Month	1	2	3	4	5
Peer-Only	Contact	0.0	0.1	0.0	0.1	0.1
	Noncontact	0.0	0.0	0.0	0.1	0.1
Peer-Mirror	Contact	0.0	0.0	0.1	0.2	0.5
	Noncontact	0.0	0.0	0.0	0.1	0.1
Mirror-Perspex	Contact	0.0	0.0	0.1	0.0	0.0
	Noncontact	0.0	0.0	0.1	0.0	0.0

3. Affiliation Table of Means (i) Rate

	Month	1	2	3	4	5
Peer-Only	Contact	0.6	0.6	1.7	1.2	0.3
	Noncontact	0.0	0.0	0.0	0.1	0.1
Peer-Mirror	Contact	1.7	1.1	0.9	0.7	0.7
	Noncontact	0.0	0.0	0.1	0.1	0.1
Mirror-Perspex	Contact	0.1	0.7	0.6	0.3	0.1
	Noncontact	0.2	0.2	0.2	0.1	0.0

(ii) Percentage of time

Peer-Only	Contact	1.9	1.6	3.4	3.8	0.3
	Noncontact	0.0	0.0	0.0	0.0	0.1
Peer-Mirror	Contact	12.4	4.1	1.7	0.4	0.3
	Noncontact	0.0	0.0	0.1	0.1	0.1
Mirror-Perspex	Contact	0.1	1.7	1.2	0.2	0.3
	Noncontact	0.1	0.2	0.5	0.0	0.0

4. Play Table of Means (i) Rate

	Month	1	2	3	4	5
Peer-Only	Contact	7.9	6.2	11.4	5.1	6.8
	Noncontact	5.6	7.0	11.4	8.3	10.3
Peer-Mirror	Contact	4.9	5.9	7.1	6.5	5.1
	Noncontact	5.2	8.5	6.4	9.7	7.5
Mirror-Perspex	Contact	0.5	0.9	0.7	0.1	0.1
	Noncontact	2.4	2.3	2.7	2.0	1.1

APPENDIX FIVE contd. 4. Play Table of Means (ii) Percentage of time

	Month	1	2	3	4	5
Peer-Only	Contact	13.2	6.7	10.2	3.0	7.4
	Noncontact	3.3	4.1	5.7	4.1	5.8
Peer-Mirror	Contact	4.9	6.0	6.4	5.2	4.0
	Noncontact	3.6	5.3	4.4	5.7	4.1
Mirror-Perspex	Contact	0.3	1.0	0.4	0.1	0.1
	Noncontact	1.1	1.2	1.4	0.9	0.6

(iii) Bout length

	PO	PM	MX
Contact	3.0	2.6	1.9
Noncontact	1.6	2.0	1.5

5. Total Responsiveness Table of Means (i) Rate

	Month	1	2	3	4	5
Peer-Only	Contact	14.0	10.8	16.1	9.0	10.9
	Noncontact	19.1	20.1	29.0	27.1	30.9
Peer-Mirror	Contact	11.7	11.0	11.2	11.5	11.2
	Noncontact	20.8	28.8	20.9	28.5	26.5
Mirror-Perspex	Contact	1.0	4.2	5.3	2.3	2.2
	Noncontact	16.1	17.5	19.5	16.3	13.2

(ii) Percentage of time

Peer-Only	Contact	19.5	11.9	15.1	8.2	10.3
	Noncontact	12.4	10.8	14.6	13.4	15.7
Peer-Mirror	Contact	22.7	13.0	10.0	8.3	8.1
	Noncontact	16.0	17.6	14.2	14.5	13.7
Mirror-Perspex	Contact	0.6	4.4	4.0	2.0	2.4
	Noncontact	9.7	9.3	9.8	7.6	6.4

(iii) Bout length

Peer-Only	Contact	4.7	4.0	2.7	2.7	2.4
	Noncontact	1.8	1.6	1.5	1.5	1.4
Peer-Mirror	Contact	6.9	4.4	2.6	2.0	2.2
	Noncontact	2.0	1.6	2.6	1.4	1.4
Mirror-Perspex	Contact	1.9	3.9	2.4	2.1	3.7
	Noncontact	1.6	2.1	1.7	1.3	1.4

APPENDIX FIVE contd. 3. Comparisons of Activity toward a Mirror and a Peer behind Perspex in the MK Pair.

1. Exploration (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	25.1	1.4	.38
Time	1, 1	0.2	61.6	.082
Form	1, 1	1408.1	72.3	.076

(ii) Percentage of time

Months	4, 4	10.5	2.1	.24
Time	1, 1	1.1	50.9	.091
Form	1, 1	384.2	154.3	.051
Months X Form	4, 4	9.5	12.9	.0172

(iii) Bout length

Months	4, 4	0.0	0.9	.55
Time	1, 1	0.8	87.3	.068
Form	1, 1	0.3	6.8	.24
Months X Time	4, 4	0.3	6.2	.054
Months X Time X Form	4, 4	0.4	6.1	.056

2. Aggression (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	0.0	3.2	.14
Time	1, 1	0.0	0.4	.64
Form	1, 1	0.0	2.7	.35

(ii) Percentage of time

Months	4, 4	0.0	2.8	.12
Time	1, 1	0.0	0.1	.83
Form	1, 1	0.0	5.0	.28
Months X Time X Form	4, 4	0.0	4.5	.088

APPENDIX FIVE contd. 3. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	0.3	3.0	.15
Time	1, 1	1.4	36.4	.11
Form	1, 1	1.9	198.7	.0443
Months X Form	4, 4	0.3	5.3	.069

(ii) Percentage of time

Months	4, 4	5.3	5.0	.076
Time	1, 1	12.3	5.4	.27
Form	1, 1	24.7	13.4	.18
Months X Time X Form	4, 4	3.7	16.4	.0118

4. Play (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	2.0	0.5	.77
Time	1, 1	21.5	548.8	.0269
Form	1, 1	44.7	325576.4	.0056

(ii) Percentage of time

Months	4, 4	1.2	1.9	.27
Time	1, 1	4.2	153.8	.051
Form	1, 1	10.2	106542.0	.0063
Time X Form	1, 1	1.1	480.5	.0286

APPENDIX FIVE contd. 5. Total Responsiveness. (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	48.9	1.1	.45
Time	1, 1	39.8	27170.0	.0078
Form	1, 1	1818.2	98.7	.064
(ii) Percentage of time				
Months	4, 4	40.0	4.9	.078
Time	1, 1	43.2	19.1	.15
Form	1, 1	315.6	36.2	.11
(iii) Bout length				
Months	4, 4	4.2	2.0	.26
Time	1, 1	0.5	0.1	.82
Form	1, 1	20.6	6.7	.24

3. Comparisons of Activity toward a Mirror and a Peer behind Perspex in the MK Pair.

Table of Means 1. Exploration (i) Rate

	Month	1	2	3	4	5
Mirror	Contact	3.2	2.4	4.8	1.7	0.5
	Noncontact	18.1	19.8	12.9	11.6	8.0
Perspex	Contact	0.4	2.6	3.7	1.8	1.9
	Noncontact	13.8	15.0	16.4	14.3	12.0
(ii) Percentage of time						
Mirror	Contact	2.2	1.5	2.5	0.9	0.2
	Noncontact	12.6	10.2	7.2	6.9	3.7
Perspex	Contact	0.3	1.7	2.4	1.7	2.0
	Noncontact	8.4	7.9	7.9	6.8	5.3

APPENDIX FIVE contd. Table of Means 1. Exploration (iii) Bout length

	Month	1	2	3	4	5
Mirror	Contact	1.9	1.7	1.4	1.3	1.3
	Noncontact	2.1	1.7	1.9	1.7	1.4
Perspex	Contact	1.7	1.8	2.0	2.7	2.9
	Noncontact	1.8	2.0	1.4	1.4	1.5

2. Aggression (i) Rate

	Month	1	2	3	4	5
Mirror	Contact	.00	.25	.07	.13	.00
	Noncontact	.00	.00	.13	.04	.00
Perspex	Contact	.00	.00	.19	.07	.03
	Noncontact	.00	.00	.13	.00	.03

(ii) Percentage of time

Mirror	Contact	.00	.10	.00	.04	.00
	Noncontact	.00	.00	.11	.00	.00
Perspex	Contact	.00	.00	.12	.03	.05
	Noncontact	.00	.02	.07	.00	.00

3. Affiliation (i) Rate

	Month	1	2	3	4	5
Mirror	Contact	1.9	1.6	0.4	0.8	0.4
	Noncontact	0.1	0.2	0.8	0.2	0.3
Perspex	Contact	0.1	0.7	0.6	0.3	0.1
	Noncontact	0.3	0.3	0.3	0.1	0.0

(ii) Percentage of time

Mirror	Contact	5.3	6.5	1.5	0.8	0.2
	Noncontact	0.1	0.1	0.8	0.1	0.1
Perspex	Contact	0.1	1.7	1.2	0.2	0.3
	Noncontact	0.1	0.2	0.5	0.0	0.0

APPENDIX FIVE contd. Table of Means. 4. Play (i) Rate

	Month	1	2	3	4	5
Mirror	Contact	2.0	1.9	1.9	0.6	0.8
	Noncontact	4.0	5.3	3.5	4.2	3.2
Perspex	Contact	0.5	0.9	0.7	0.1	0.1
	Noncontact	2.4	2.3	2.7	2.0	1.1

(ii) Percentage of time

Mirror	Contact	0.9	0.3	1.0	0.3	0.3
	Noncontact	2.0	3.2	1.7	1.8	1.3
Perspex	Contact	0.3	1.0	0.4	0.1	0.1
	Noncontact	1.1	1.2	1.4	0.9	0.6

5. Total Responsiveness Table of Means. (i) Rate

	Month	1	2	3	4	5
Mirror	Contact	7.1	6.2	7.2	3.2	1.6
	Noncontact	22.3	25.3	17.3	16.0	11.5
Perspex	Contact	1.0	4.2	5.3	2.3	2.2
	Noncontact	16.1	17.5	19.5	16.3	13.2

(ii) Percentage of time

Mirror	Contact	8.4	9.0	5.0	2.0	0.8
	Noncontact	14.7	13.5	9.7	8.8	5.1
Perspex	Contact	0.6	4.4	4.0	2.0	2.4
	Noncontact	9.7	9.3	9.8	7.6	6.4

(iii) Bout length

Mirror	Contact	3.7	6.6	3.0	1.8	1.4
	Noncontact	1.8	1.6	1.7	1.4	1.4
Perspex	Contact	1.9	3.9	2.4	2.1	3.7
	Noncontact	1.6	2.1	1.7	1.3	1.4

APPENDIX FIVE contd. 4. Comparisons of Activity toward a Cagemate and a Mirror in the PM Pair.

1. Exploration (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	1.1	0.1	.99
Time	1, 1	68.2	1.2	.47
Form	1, 1	1473.4	454.2	.0203

(ii) Percentage of time

Months	4, 4	11.8	1.8	.30
Time	1, 1	31.5	0.7	.57
Form	1, 1	405.3	1328.1	.0163
Months X Time X Form	4, 4	2.0	6.7	.0486

(iii) Bout length

Months	4, 4	1.1	2.9	.17
Time	1, 1	0.1	0.0	.86
Form	1, 1	1.8	103.2	.063

2. Aggression (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	0.3	3.0	.16
Time	1, 1	0.0	2.7	.35
Form	1, 1	0.1	20.2	.15
Months X Time	4, 4	0.2	31.9	.0045
Months X Time X Form	4, 4	0.1	4.5	.089

(ii) Percentage of time

Months	4, 4	0.1	1.9	.23
Time	1, 1	0.0	0.4	.62
Form	1, 1	0.1	118.6	.058
Months X Time	4, 4	0.1	20.7	.0084
Months X Time X Form	4, 4	0.0	5.8	.060

APPENDIX FIVE contd. 3. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	0.2	3.2	.14
Time	1, 1	0.0	0.0	.99
Form	1, 1	8.4	3.1	.34
Months X Form	4, 4	0.2	4.8	.081

(ii) Percentage of time

Months	4, 4	9.2	0.9	.54
Time	1, 1	7.6	0.7	.56
Form	1, 1	84.3	1.8	.41

4. Play (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	8.2	0.3	.37
Time	1, 1	68.6	45.2	.097
Form	1, 1	57.2	66932.1	.0067

(ii) Percentage of time

Months	4, 4	5.7	0.3	.84
Time	1, 1	62.1	90.2	.067
Form	1, 1	2.5	3.9	.30

(iii) Bout length

Months	4, 4	0.4	2.8	.17
Time	1, 1	3.3	19.1	.15
Form	1, 1	1.0	28.3	.12
Months X Time	4, 4	0.1	5.5	.066

APPENDIX FIVE contd. 5. Total Responsiveness (i) Rate

Source	DF	MS	F	Prob.
Months	4, 4	10.7	0.1	.96
Time	1, 1	280.0	8.6	.22
Form	1, 1	1830.3	19939.0	.0083

(ii) Percentage of time

Months	4, 4	47.9	4.0	.10
Time	1, 1	289.8	3.9	.31
Form	1, 1	155.9	4.4	.29
Time X Form	1, 1	13.3	252.3	.0392

(iii) Bout length

Months	4, 4	5.0	0.8	.59
Time	1, 1	0.0	0.0	.98
Form	1, 1	26.4	13.4	.18

4. Comparisons of Activity toward a Cagemate and a Mirror in the PM Pair.

Table of Means 1. Exploration (i) Rate

	Month	1	2	3	4	5
Peer	Contact	5.2	4.0	3.1	4.0	4.6
	Noncontact	15.4	20.2	14.4	18.3	18.7
Mirror	Contact	4.0	3.3	3.1	1.7	1.2
	Noncontact	13.9	12.5	15.3	13.9	13.1

(ii) Percentage of time

Peer	Contact	5.4	2.9	1.8	2.6	2.0
	Noncontact	12.4	12.3	9.8	8.6	7.9
Mirror	Contact	3.7	2.1	1.8	1.0	1.7
	Noncontact	9.2	6.5	8.2	7.2	6.6

APPENDIX FIVE contd. Table of Means 1. Exploration

(iii) Bout length

	Month	1	2	3	4	5
Peer	Contact	3.1	2.1	1.7	2.0	1.9
	Noncontact	2.3	1.9	2.0	1.4	1.6
Mirror	Contact	2.8	1.9	1.6	1.7	2.9
	Noncontact	2.0	1.5	1.6	1.5	1.6

2. Aggression (i) Rate

	Month	1	2	3	4	5
Peer	Contact	.00	.00	.14	.22	.78
	Noncontact	.03	.07	.00	.34	.26
Mirror	Contact	.05	.00	.07	.91	.03
	Noncontact	.09	.00	.00	.31	.00

(ii) Percentage of time

Peer	Contact	.00	.00	.07	.19	.51
	Noncontact	.02	.02	.00	.13	.08
Mirror	Contact	.02	.00	.07	.57	.01
	Noncontact	.04	.00	.00	.16	.00

3. Affiliation (i) Rate

	Month	1	2	3	4	5
Peer	Contact	1.7	1.1	0.9	0.7	0.7
	Noncontact	0.0	0.0	0.1	0.1	0.1
Mirror	Contact	0.4	0.7	2.0	1.2	0.6
	Noncontact	0.0	0.1	0.0	0.1	0.2

(ii) Percentage of time

Peer	Contact	12.4	4.1	1.7	0.4	0.8
	Noncontact	0.0	0.0	0.1	0.1	0.1
Mirror	Contact	0.8	2.1	2.4	2.2	2.9
	Noncontact	0.1	0.1	0.0	0.1	0.2

APPENDIX FIVE contd. Table of Means 4. Play (i) Rate

	Month	1	2	3	4	5
Peer	Contact	4.9	5.9	7.1	6.5	5.2
	Noncontact	5.2	8.5	6.4	9.7	7.5
Mirror	Contact	3.3	4.3	2.9	1.1	0.6
	Noncontact	5.8	7.6	7.1	5.2	2.6

(ii) Percentage of time

Peer	Contact	4.9	6.0	6.4	5.2	4.0
	Noncontact	3.6	5.3	4.4	5.7	4.1
Mirror	Contact	2.5	3.0	1.6	0.6	0.5
	Noncontact	3.9	4.9	3.9	2.5	1.3

(iii) Bout length

Peer	Contact	2.9	3.0	2.4	2.2	2.3
	Noncontact	1.9	1.7	3.0	1.8	1.7
Mirror	Contact	1.9	1.9	1.7	1.6	1.7
	Noncontact	1.9	1.9	1.6	1.5	1.5

5. Total Responsiveness Table of Means (i) Rate

	Month	1	2	3	4	5
Peer	Contact	11.7	11.0	11.2	11.5	11.2
	Noncontact	20.8	28.8	20.9	28.5	26.5
Mirror	Contact	7.8	8.3	8.1	5.0	2.4
	Noncontact	19.7	20.2	22.5	19.5	15.9

(ii) Percentage of time

Peer	Contact	22.7	13.0	10.0	8.3	8.1
	Noncontact	16.0	17.6	14.2	14.5	13.7
Mirror	Contact	7.0	7.2	5.7	4.4	5.1
	Noncontact	13.3	11.4	12.1	9.9	8.1

(iii) Bout length

Peer	Contact	6.9	4.4	2.6	2.0	2.2
	Noncontact	2.0	1.6	2.6	1.4	1.4
Mirror	Contact	2.9	3.3	1.9	2.1	6.9
	Noncontact	3.2	1.8	1.7	1.5	2.1

APPENDIX SIX. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM NOVEL ENVIRONMENT AND SLIDE TEST ANALYSES

1. Novel Environment Tests

1. Environment- and self-directed activity

Source	DF	MS	F	Prob.
Social Partner	1, 6	98.0	1.0	.35
Environment	1, 6	1365.0	83.1	.0002
Days	3, 18	15.3	4.8	.0124
Blocks	3, 18	91.6	19.3	.0000
Behaviour	2, 12	6043.6	76.0	.0000
Social Partner X Behaviour	2, 12	425.5	5.4	.0216
Direction	1, 6	1460.9	4.8	.07
Social Partner X Environment X Days	3, 18	15.8	4.4	.0166
Environment X Behaviour	2, 12	972.0	43.9	.0000
Environment X Direction	1, 6	2959.3	29.2	.0019
Days X Blocks	9, 54	12.5	3.1	.0048
Social Partner X Days X Blocks	9, 54	8.4	2.1	.0498
Days X Direction	3, 18	68.6	4.0	.0250
Blocks X Behaviour	6, 36	45.6	8.2	.0000
Blocks X Direction	3, 18	34.7	4.1	.0219
Behaviour X Direction	2, 12	3662.2	25.0	.0001
Environment X Days X Behaviour	6, 36	15.9	2.7	.0291
Environment X Behaviour X Direction	2, 12	706.3	11.5	.0017
Days X Behaviour X Direction	6, 36	49.0	4.1	.0034
Blocks X Behaviour X Direction	6, 36	56.1	8.4	.0000
Social Partner X Blocks X Behaviour X Direction	6, 36	32.1	4.8	.0011
Social Partner X Days X Blocks X Behaviour X Direction	18, 108	9.7	1.7	.0486

2. Diaper-directed activity

Source	DF	MS	F	Prob.
Social Partner	1, 6	2362.5	19.0	.0051
Environment	1, 6	3760.6	307.0	.0000
Social Partner X Environment	1, 6	611.0	51.1	..0005

APPENDIX SIX contd. 2. Diaper-directed activity

Source	DF	MS	F	Prob.
Days	3, 18	63.2	2.7	.08
Blocks	3, 18	10.6	1.2	.36
Behaviour	2, 12	34.2	0.4	.69
Social Partner X Behaviour	2, 12	995.8	11.6	.0017
Social Partner X Environment X Behaviour	2, 12	732.9	8.3	.0056
Social Partner X Days X Behaviour	6, 36	30.4	2.4	.0450
Blocks X Behaviour	6, 36	49.8	3.9	.0044

3. Locomotion and vocalization. Locomotion:

Source	DF	MS	F	Prob.
Social Partner	1, 6	53.8	0.4	.55
Environment	1, 6	919.1	2.7	.15
Days	3, 18	22.7	0.7	.59
Blocks	3, 18	103.8	5.4	.0078
Behaviour	1, 6	1176.1	13.2	.0112
Environment X Blocks	3, 18	53.2	3.2	.0490
Environment X Behaviour	1, 6	1339.0	14.6	.0090

Vocalization:

Source	DF	MS	F	Prob.
Social Partner	1, 6	212.1	2.4	.17
Environment	1, 6	9937.6	168.0	.0000
Days	3, 18	33.4	2.1	.13
Blocks	3, 18	72.3	6.7	.0032
Environment X Blocks	3, 18	39.6	3.9	.0271
Environment X Days X Blocks	9, 54	10.5	2.1	.0453

4. Play

Source	DF	MS	F	Prob.
Social Partner	1, 6	43.1	0.3	.59
Days	3, 18	24.0	2.5	.09
Blocks	3, 18	43.8	4.1	.0214
Direction	1, 6	1595.0	95.1	.0001
Days X Blocks X Direction	9, 54	15.2	2.6	.0156

APPENDIX SIX contd. 5. The isolation syndrome.

Source	DF	MS	F	Prob.
Social Partner	1, 6	143.3	2.8	.14
Environment	1, 6	57.7	2.9	.14
Days	3, 18	2.3	0.4	.79
Blocks	3, 18	7.0	3.7	.0298
Behaviour	3, 18	46.5	1.1	.40
Blocks X Behaviour	9, 54	6.7	2.9	.0081

6. Self-looking, drinking, and scratching.

Look Self:

Source	DF	MS	F	Prob.
Social Partner	1, 6	112.9	40.8	.0009
Environment	1, 6	0.3	0.1	.82
Days	3, 18	2.6	2.2	.12
Blocks	3, 18	4.1	1.2	.32
Social Partner X Environment X Days X Blocks	9, 54	2.7	2.3	.0308

Drink:

Source	DF	MS	F	Prob.
Social Partner	1, 6	0.4	0.1	.82
Environment	1, 6	11.4	3.2	.12
Days	3, 18	0.4	0.2	.88
Blocks	3, 18	7.4	2.9	.07
Days X Blocks	9, 54	3.4	3.0	.0063

Scratch:

Source	DF	MS	F	Prob.
Social Partner	1, 6	21.4	12.4	.0126
Environment	1, 6	17.0	3.4	.11
Days	3, 18	0.4	0.4	.79
Blocks	3, 18	3.1	2.9	.06

2. Slide Tests. 1. Exploration. (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	50.3	0.1	.73
Session	1, 6	4.6	0.1	.82
Age	1, 6	116.3	7.1	.0367
Expression	1, 6	3.8	0.2	.71
Form	1, 6	11811.9	56.4	.0004
Session X Form	1, 6	156.2	11.7	.0144
Social Partner X Session X Form	1, 6	238.7	17.8	.0059

APPENDIX SIX contd. 1. Exploration (i) Rate contd.

Source	DF	MS	F	Prob.
Age X Form	1, 6	39.6	27.6	.0022
Social Partner X Age X Form	1, 6	17.3	12.0	.0134
Expression X Form	1, 6	75.3	8.4	.0272
Adult Male Threat Test:				
Social Partner	1, 6	45.8	0.8	.58
Session	1, 6	3.5	0.5	.50
Form	1, 6	3364.1	74.8	.0002
Session X Form	1, 6	61.9	6.9	.0390
(ii) Percentage of time				
Social Partner	1, 6	3.6	0.1	.81
Session	1, 6	43.8	0.9	.62
Age	1, 6	61.2	1.8	.23
Expression	1, 6	75.5	5.2	.06
Form	1, 6	2142.7	16.7	.0068
Session X Age X Expression	1, 6	112.3	8.4	.0271
Social Partner X Session X Age X Form	1, 6	93.0	17.8	.0059
Social Partner X Session X Age X Expression X Form	1, 6	25.7	7.0	.0378
Adult Male Threat Test:				
Social Partner	1, 6	31.0	1.1	.35
Session	1, 6	0.2	0.1	.83
Form	1, 6	868.4	22.0	.0027
(iii) Bout length				
Social Partner	1, 6	1.0	1.2	.32
Session	1, 6	0.1	0.0	.84
Age	1, 6	0.0	0.0	.89
Expression	1, 6	1.0	2.9	.14
Adult Male Threat Test:				
Social Partner	1, 6	0.0	0.0	.99
Session	1, 6	0.1	0.7	.57

APPENDIX SIX contd. 2. Play (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	9.5	1.0	.64
Session	1, 6	0.2	0.0	.86
Age	1, 6	10.8	3.1	.13
Expression	1, 6	4.5	3.4	.11
Form	1, 6	7.0	1.0	.36
Session X Age X Expression	1, 6	1.5	8.0	.0297
Session X Age X Expression X Form	1, 6	8.3	6.1	.0479
Adult Male Threat Test:				
Social Partner	1, 6	1.1	0.9	.61
Session	1, 6	3.9	2.2	.19
Form	1, 6	3.9	3.0	.14
(ii) Percentage of time				
Social Partner	1, 6	1.3	0.9	.62
Session	1, 6	0.2	0.2	.70
Age	1, 6	1.6	3.4	.11
Expression	1, 6	0.6	2.7	.15
Form	1, 6	0.7	0.8	.59
Session X Age X Expression	1, 6	0.2	6.4	.0441
Session X Age X Expression X Form	1, 6	1.1	6.4	.0440
Adult Male Threat Test:				
Social Partner	1, 6	0.2	2.0	.20
Session	1, 6	0.3	1.5	.27
Form	1, 6	0.4	4.0	.09

3. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 6	12.4	5.3	.06
Session	1, 6	1.6	0.3	.57
Age	1, 6	0.1	0.1	.73
Expression	1, 6	0.6	0.1	.73
Form	1, 6	0.1	0.1	.33
Social Partner X Session X Expression	1, 6	1.0	8.7	.0256

APPENDIX SIX contd. 3. Affiliation (i) Rate Adult Male Threat Test:

Source	DF	MS	F	Prob.
Social Partner	1, 6	4.5	2.7	.15
Session	1, 6	2.3	0.5	.51
Form	1, 6	4.5	9.5	.0214
(ii) Percentage of time				
Social Partner	1, 6	2.1	6.4	.0439
Session	1, 6	0.5	1.0	.36
Age	1, 6	0.1	0.5	.52
Expression	1, 6	0.2	0.2	.71
Form	1, 6	0.0	0.1	.82
Social Partner X Session X Age X Form	1, 6	1.2	6.1	.0470
Age X Expression X Form	1, 6	0.9	10.9	.0165
Adult Male Threat Test:				
Social Partner	1, 6	0.1	0.1	.74
Session	1, 6	1.0	1.2	.31
Form	1, 6	1.1	10.3	.0168

APPENDIX SEVEN. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM FILM - MIRROR REACTION TEST ANALYSES

1. Exploration. (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	567.0	10.5	.0323
Additional Experience	1, 4	5.9	0.1	.75
Stimulus	1, 4	236.0	12.3	.0257
Social Partner X Stimulus	1, 4	262.3	13.7	.0219
Social Partner X Additional Experience X Stimulus	1, 4	195.0	10.2	.0341
Presentation	1; 4	204.2	14.4	.0202
Form	1, 4	13016.0	401.5	.0003
Presentation X Form	1, 4	45.7	15.4	.0184

(ii) Percentage of time

Social Partner	1, 4	150.4	20.4	.0119
Additional Experience	1, 4	21.7	3.0	.16
Stimulus	1, 4	16.1	3.6	.13
Social Partner X Stimulus	1, 4	92.4	20.4	.0119
Additional Experience X Stimulus	1, 4	50.6	11.2	.0297
Social Partner X Additional Experience X Stimulus	1, 4	95.8	21.2	.0113
Presentation	1, 4	75.9	8.0	.0477
Form	1, 4	3165.5	101.2	.0012

(iii) Bout length

Social Partner	1, 4	0.0	0.0	.94
Additional Experience	1, 4	0.1	0.6	.51
Stimulus	1, 4	0.0	0.4	.55
Presentation	1, 4	0.0	0.0	.88

APPENDIX SEVEN contd. 2. Play. (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	2.0	0.2	.69
Additional Experience	1, 4	54.0	4.8	.09
Stimulus	1, 4	22.6	17.4	.0153
Presentation	1, 4	19.6	1.3	.32
Form	1, 4	4.5	1.2	.33

(ii) Percentage of time

Social Partner	1, 4	1.7	0.5	.53
Additional Experience	1, 4	11.0	3.2	.15
Stimulus	1, 4	5.5	5.2	.09
Presentation	1, 4	4.5	1.1	.36
Form	1, 4	0.4	1.2	.34

3. Affiliation. (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	0.6	0.0	.85
Additional Experience	1, 4	2.5	0.1	.72
Stimulus	1, 4	183.6	13.2	.0231
Presentation	1, 4	12.1	3.0	.16
Form	1, 4	15.0	1.9	.25

(ii) Percentage of time

Social Partner	1, 4	0.5	0.1	.83
Additional Experience	1, 4	0.3	0.0	.88
Stimulus	1, 4	71.6	11.9	.0269
Presentation	1, 4	10.3	1.7	.27
Form	1, 4	0.1	0.0	.89

APPENDIX EIGHT. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUESFROM HOME CAGE MIRROR-REACTION TEST ANALYSES

1. Aggression (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	.02	2.3	.21
Additional Experience	1, 4	.07	6.9	.06
Social Partner X Additional Experience	1, 4	.09	8.8	.0421
Days	4, 16	.24	6.9	.0021
Social Partner X Additional Experience X Days	4, 16	.32	9.0	.0006
Blocks	3, 12	.20	2.4	.12
Form	1, 4	.01	0.2	.67
Social Partner X Days X Blocks	12, 48	.23	2.4	.0163

(ii) Percentage of time

Social Partner	1, 4	.00	0.3	.63
Additional Experience	1, 4	.01	1.6	.27
Days	4, 16	.04	6.9	.0021
Social Partner X Days	4, 16	.02	3.0	.0481
Social Partner X Additional Experience X Days	4, 16	.06	9.2	.0005
Blocks	3, 12	.04	3.0	.08
Form	1, 4	.01	1.1	.35
Days X Blocks	12, 48	.04	2.6	.0099
Social Partner X Days X Blocks	12, 48	.04	2.9	.0045

Table of Means. (i) Rate

		Day	1	2	3	4	5
		Block					
Mirror-Only	Contact	1	.00	.00	.00	.65	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	2	.00	.00	.70	.00	.00
	Noncontact		.00	.00	.70	.00	.00
	Contact	3	.00	.00	.65	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	.65	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00

APPENDIX EIGHT contd. Table of Means (contd.) 1. Aggression

(i) Rate

		Day	1	2	3	4	5
		Block					
Mirror-Perspex	Contact	1	.00	.00	.00	.00	.50
	Noncontact		.00	.50	.00	.00	.50
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	1.0	.00	.00	.00	.00
	Noncontact		1.0	.00	.00	.00	.00
Peer-Only	Contact	1	.50	.00	.00	.00	.00
	Noncontact		.50	.00	.00	.00	1.5
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.50	.00	.00	.00	.00
	Noncontact		.50	.00	.00	.00	.00
	Contact	4	.00	.00	.00	.00	.50
	Noncontact		.00	.00	.00	.00	.00
Peer-Mirror	Contact	1	.00	.00	.00	.00	.00
	Noncontact		.50	.00	.00	.00	.50
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	.50	.00	.00	.00	.00
	Noncontact		.00	.00	.50	.00	.00

(ii) Percentage of time

		Day	1	2	3	4	5
		Block					
Mirror-Only	Contact	1	.00	.00	.00	.20	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	2	.00	.00	.20	.00	.00
	Noncontact		.00	.00	.25	.00	.00
	Contact	3	.00	.00	.35	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	.20	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
Mirror-Perspex	Contact	1	.00	.00	.00	.00	.25
	Noncontact		.00	.15	.00	.00	.15
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	.30	.00	.00	.00	.00
	Noncontact		.60	.00	.00	.00	.00

APPENDIX EIGHT contd. Table of Means (contd.) 1. Aggression

(ii) Percentage of time

		Day	1	2	3	4	5
		Block					
Peer-Only	Contact	1	.15	.00	.00	.00	.00
	Noncontact		.25	.00	.00	.00	.80
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.10	.00	.00	.00	.00
	Noncontact		.15	.00	.00	.00	.00
	Contact	4	.00	.00	.00	.00	.25
	Noncontact		.00	.00	.00	.00	.00
Peer-Mirror	Contact	1	.00	.00	.00	.00	.00
	Noncontact		.20	.00	.00	.00	.20
	Contact	2	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	3	.00	.00	.00	.00	.00
	Noncontact		.00	.00	.00	.00	.00
	Contact	4	.25	.00	.00	.00	.00
	Noncontact		.00	.00	.20	.00	.00

2. Exploration (i) Rate

		Day	1	2	3	4	5
		Block					
Mirror-Only	Contact	1	3.3	7.5	13.5	3.4	14.5
	Noncontact		29.2	22.2	18.2	19.2	32.2
	Contact	2	2.5	4.7	13.0	4.6	5.4
	Noncontact		18.5	25.5	13.5	9.8	11.4
	Contact	3	3.8	7.3	14.1	5.2	5.3
	Noncontact		25.9	19.7	22.0	18.1	20.3
	Contact	4	6.9	11.4	5.6	11.5	2.0
	Noncontact		20.8	25.5	13.8	10.8	9.9
Mirror-Peer	Contact	1	6.0	1.5	3.0	0.5	5.0
	Noncontact		19.6	16.1	10.5	6.9	29.1
	Contact	2	6.5	0.5	4.0	0.0	1.0
	Noncontact		12.5	20.0	9.0	3.0	11.1
	Contact	3	7.0	0.6	1.1	0.0	2.0
	Noncontact		17.5	6.3	11.7	10.2	21.5
	Contact	4	12.5	4.0	2.6	0.5	0.0
	Noncontact		14.5	6.5	21.4	9.4	11.1

APPENDIX EIGHT contd. Table of Means (contd.) 2. Exploration

(i) Rate

		Day / Block	1	2	3	4	5
Peer-Only	Contact	1	16.5	8.7	6.0	8.0	8.5
	Noncontact		37.6	28.4	20.6	17.1	26.6
	Contact	2	13.6	5.5	3.0	5.1	1.5
	Noncontact		32.1	20.8	14.1	29.8	14.6
	Contact	3	12.5	10.1	6.1	2.5	2.5
	Noncontact		27.5	17.1	20.9	22.5	15.6
	Contact	4	18.2	7.1	5.6	2.0	4.0
	Noncontact		28.3	27.7	15.6	17.5	16.5
Peer-Mirror	Contact	1	6.6	2.5	1.0	2.0	9.1
	Noncontact		39.4	21.1	18.6	16.2	28.3
	Contact	2	4.5	0.5	4.3	0.0	1.6
	Noncontact		39.6	11.7	18.9	10.2	14.4
	Contact	3	9.8	1.1	0.5	4.1	3.5
	Noncontact		28.1	13.8	17.6	19.1	13.0
	Contact	4	4.5	3.1	3.5	1.0	5.1
	Noncontact		27.7	15.2	17.6	8.6	17.3

(i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	522.0	4.6	.10
Additional Experience	1, 4	1430.2	12.7	.0247
Days	4, 16	647.2	11.6	.0002
Social Partner X Days	4, 16	219.8	3.9	.0209
Blocks	3, 12	257.8	9.1	.0022
Form	1, 4	14616.5	1013.7	.0002
Social Partner X Form	1, 4	410.2	28.5	.0072
Blocks X Form	3, 12	95.9	3.7	.0427

(ii) Percentage of time

Social Partner	1, 4	289.0	2.8	.17
Additional Experience	1, 4	1204.0	11.8	.0274
Days	4, 16	95.3	3.8	.0240
Social Partner X Days	4, 16	91.1	3.6	.0280
Additional Experience X Days	4, 16	127.3	5.0	.0081
Blocks	3, 12	155.9	6.6	.0070
Form	1, 4	2978.6	156.5	.0007
Days X Blocks	12, 48	55.5	2.5	.0140
Blocks X Form	3, 12	42.7	4.4	.0256

APPENDIX EIGHT contd. Table of Means. 2. Exploration.

(ii) Percentage of time

		Day / Block	1	2	3	4	5
Mirror-Only	Contact	1	1.5	19.8	9.9	2.3	8.4
	Noncontact		10.0	17.3	9.6	8.6	17.4
	Contact	2	1.1	3.6	12.6	6.2	5.7
	Noncontact		7.3	13.7	6.0	5.2	8.9
	Contact	3	1.4	7.3	9.0	3.1	3.9
	Noncontact		11.0	13.3	15.0	12.7	11.3
	Contact	4	5.2	10.9	2.5	6.1	0.7
	Noncontact		9.2	10.3	5.3	5.6	7.8
Mirror-Perspex	Contact	1	2.4	0.6	1.2	0.2	3.0
	Noncontact		7.9	7.8	6.5	2.5	21.4
	Contact	2	2.0	0.6	2.8	0.0	0.5
	Noncontact		6.1	12.5	4.7	1.1	4.8
	Contact	3	3.2	1.2	0.3	0.0	1.1
	Noncontact		9.1	1.8	4.8	4.1	10.6
	Contact	4	5.7	2.7	1.2	0.5	0.0
	Noncontact		7.1	3.2	8.6	5.7	4.8
Peer-Only	Contact	1	9.6	6.2	7.9	3.7	5.4
	Noncontact		20.3	18.1	14.5	12.7	23.6
	Contact	2	10.0	2.6	2.6	2.6	0.8
	Noncontact		13.5	10.9	7.7	15.9	8.9
	Contact	3	10.8	15.3	3.6	4.4	1.7
	Noncontact		12.1	11.0	9.2	19.7	6.9
	Contact	4	13.5	6.3	9.5	2.5	4.3
	Noncontact		14.2	22.2	7.2	15.3	7.7
Peer-Mirror	Contact	1	5.2	1.2	0.7	0.9	10.3
	Noncontact		20.9	8.9	9.4	6.7	19.0
	Contact	2	1.9	0.3	2.4	0.0	1.9
	Noncontact		17.2	5.4	13.8	4.0	8.9
	Contact	3	4.6	0.5	0.2	5.3	2.7
	Noncontact		13.7	6.6	11.5	7.2	5.2
	Contact	4	3.0	2.4	2.0	0.5	2.6
	Noncontact		11.7	5.2	8.8	4.1	10.4

(iii) Bout length

Source	DF	MS	F	Prob.
Social Partner	1, 4	0.3	0.5	.51
Additional Experience	1, 4	2.7	5.1	.09
Days	4, 16	0.4	0.8	.57
Blocks	3, 12	0.4	1.7	.22
Days X Blocks	12, 48	0.5	2.6	.0093

APPENDIX EIGHT contd. Table of Means. 2. Exploration

(iii) Bout length

	Day Block	1	2	3	4	5
Mirror-Only	1	1.2	2.5	2.0	1.4	1.7
	2	1.4	1.8	1.3	1.6	2.3
	3	1.3	2.3	2.0	2.1	1.7
	4	1.4	1.2	1.2	2.5	1.3
Mirror-Perspex	1	1.2	1.4	2.2	1.1	2.2
	2	1.6	1.8	1.5	1.1	1.3
	3	1.6	0.9	1.3	1.3	1.7
	4	1.7	1.6	1.2	1.8	1.3
Peer-Only	1	1.7	1.9	2.2	2.3	2.6
	2	1.3	1.6	1.5	1.6	1.8
	3	1.4	1.8	1.3	2.6	1.3
	4	1.6	2.5	1.4	2.6	1.4
Peer-Mirror	1	1.6	1.3	1.5	1.4	2.0
	2	1.4	1.8	2.4	1.4	1.8
	3	1.5	1.5	2.0	1.3	1.1
	4	1.3	1.0	1.5	1.4	1.6

3. Play (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	150.3	4.5	.10
Additional Experience	1, 4	1215.6	36.2	.0050
Days	4, 16	62.6	0.5	.73
Blocks	3, 12	103.3	3.9	.0363
Social Partner X Additional Experience X Blocks	3, 12	154.7	5.9	.0106
Form	1, 4	920.4	90.1	.0014
Additional Experience X Form	1, 4	102.0	10.0	.0349
Social Partner X Additional Experience X Form	1, 4	216.7	21.2	.0113

APPENDIX EIGHT contd. Table of Means. 3. Play (i) Rate

		Day	1	2	3	4	5
		Block					
Mirror-Only	Contact	1	0.7	0.0	0.0	4.5	9.6
	Noncontact		1.7	4.5	2.7	11.0	13.1
	Contact	2	0.0	1.0	2.1	0.5	3.2
	Noncontact		0.5	2.8	2.1	14.6	5.8
	Contact	3	0.0	0.7	6.0	3.0	4.6
	Noncontact		6.8	7.1	14.8	9.5	11.7
	Contact	4	3.3	4.3	5.9	6.0	11.2
	Noncontact		4.3	11.9	20.3	13.5	27.6
Mirror-Perspex	Contact	1	0.5	0.5	2.0	0.0	2.5
	Noncontact		1.0	3.0	0.0	0.0	1.5
	Contact	2	0.0	0.5	0.0	0.0	0.5
	Noncontact		0.0	1.1	0.5	0.0	2.0
	Contact	3	2.0	0.0	0.5	0.0	1.0
	Noncontact		0.5	0.6	1.0	0.0	3.5
	Contact	4	1.0	0.5	0.0	0.0	0.0
	Noncontact		2.5	1.0	0.0	0.0	2.0
Peer-Only	Contact	1	9.7	6.7	1.5	4.0	1.5
	Noncontact		10.9	10.4	7.0	5.5	7.5
	Contact	2	18.1	4.0	3.5	1.0	0.0
	Noncontact		15.1	7.6	5.5	8.6	4.5
	Contact	3	12.0	2.0	3.0	0.0	1.0
	Noncontact		12.5	3.0	7.7	8.7	5.0
	Contact	4	14.1	2.5	2.0	0.5	3.5
	Noncontact		13.6	4.5	5.5	4.0	5.0
Peer-Mirror	Contact	1	1.0	3.0	1.5	0.0	0.0
	Noncontact		5.5	10.1	9.5	1.0	0.5
	Contact	2	0.5	0.0	1.7	0.0	1.6
	Noncontact		6.5	0.9	5.2	0.5	3.1
	Contact	3	7.5	0.0	0.5	0.0	0.5
	Noncontact		9.6	1.2	9.0	1.5	6.5
	Contact	4	2.5	6.6	1.5	0.0	6.1
	Noncontact		10.6	15.2	3.5	0.5	15.8

(ii) Percentage of time

Source	DF	MS	F	Prob.
Social Partner	1, 4	74.9	3.3	.14
Additional Experience	1, 4	384.1	16.8	.0161
Days	4, 16	15.4	0.2	.87
Blocks	3, 12	38.5	2.5	.11
Social Partner X Additional Experienc X Blocks	3, 12	69.0	4.6	.0235
Form	1, 4	330.5	52.4	.0029
Social Partner X Additional Experience X Form	1, 4	103.7	16.5	.0166

APPENDIX EIGHT contd. Table of Means. 3. Play (ii) Percentage of time

		Day Block	1	2	3	4	5
Mirror-Only	Contact	1	0.2	0.0	0.0	3.1	4.8
	Noncontact		0.8	2.7	2.0	5.6	6.8
	Contact	2	0.0	0.3	0.8	0.4	3.0
	Noncontact		0.3	1.6	0.7	10.9	3.5
	Contact	3	0.0	0.2	3.2	1.7	2.6
	Noncontact		4.0	3.5	11.6	5.4	6.6
	Contact	4	1.4	2.4	4.5	3.1	6.9
	Noncontact		2.2	7.0	12.1	8.8	18.1
Mirror-Perspex	Contact	1	0.2	0.2	0.8	0.0	1.4
	Noncontact		0.4	1.2	0.0	0.0	1.0
	Contact	2	0.0	0.4	0.0	0.0	0.2
	Noncontact		0.0	0.4	0.3	0.0	0.7
	Contact	3	1.0	0.0	0.2	0.0	0.5
	Noncontact		0.2	0.2	1.3	0.0	1.3
	Contact	4	0.4	0.2	0.0	0.0	0.0
	Noncontact		1.2	0.4	0.0	0.0	0.8
Peer-Only	Contact	1	5.0	3.5	1.0	1.7	0.6
	Noncontact		5.2	8.7	3.9	4.2	4.0
	Contact	2	11.8	2.3	4.7	0.5	0.0
	Noncontact		7.9	3.9	3.4	5.5	2.8
	Contact	3	6.7	0.9	1.6	0.0	0.7
	Noncontact		6.1	1.1	4.0	6.8	2.0
	Contact	4	9.6	1.1	1.3	0.3	1.8
	Noncontact		5.8	2.3	3.0	2.8	3.3
Peer-Mirror	Contact	1	0.4	2.3	0.7	0.0	0.0
	Noncontact		2.8	8.4	8.3	0.4	0.2
	Contact	2	0.3	0.0	0.9	0.0	1.1
	Noncontact		2.9	0.5	4.0	0.2	1.6
	Contact	3	8.2	0.0	0.4	0.0	0.2
	Noncontact		7.7	0.7	5.6	0.8	3.2
	Contact	4	1.4	4.6	0.9	0.0	4.7
	Noncontact		5.4	11.0	1.8	0.1	12.1

(iii) Bout length

Source	DF	MS	F	Prob.
Social Partner	1, 4	0.1	0.5	.52
Additional Experience	1, 4	0.0	0.2	.71
Form	1, 4	0.1	0.4	.58

APPENDIX EIGHT contd. 4. Affiliation (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	4.0	0.3	.63
Additional Experience	1, 4	2.0	0.1	.73
Days	4, 16	13.2	4.4	.0136
Blocks	3, 12	6.5	2.7	.09
Form	1, 4	40.5	4.8	.09
Social Partner X Additional Experience X Form	1, 4	83.6	9.9	.0353
Days X Blocks	12, 48	8.3	4.7	.0001
Social Partner X Additional Experience X Days X Form	4, 16	7.8	3.2	.0409

Table of Means:

		Day	1	2	3	4	5
		Block					
Mirror-Only	Contact	1	0.0	1.3	3.5	2.6	6.7
	Noncontact		0.0	0.0	0.0	0.0	1.0
	Contact	2	0.0	0.0	7.2	5.1	6.0
	Noncontact		0.0	0.0	0.0	0.0	0.0
	Contact	3	2.2	0.7	3.4	2.0	3.5
	Noncontact		0.0	0.0	0.0	0.0	0.7
	Contact	4	0.0	2.0	3.6	9.3	0.0
	Noncontact		0.0	0.0	0.0	0.0	0.0
Mirror-Partner	Contact	1	0.0	0.0	1.5	0.0	2.0
	Noncontact		1.0	0.5	2.5	0.5	5.0
	Contact	2	0.5	0.5	0.5	0.0	0.5
	Noncontact		0.5	0.0	0.5	0.5	1.5
	Contact	3	0.5	0.6	0.0	0.5	0.5
	Noncontact		0.5	0.0	1.5	1.0	1.0
	Contact	4	0.5	0.0	0.0	1.6	0.0
	Noncontact		2.0	0.0	2.1	0.0	0.5
Peer-Only	Contact	1	1.0	2.6	0.5	0.5	0.5
	Noncontact		1.0	0.0	1.0	0.0	5.5
	Contact	2	0.0	0.5	0.5	0.5	1.0
	Noncontact		0.0	0.5	0.5	0.0	2.6
	Contact	3	0.0	1.5	0.0	0.0	0.0
	Noncontact		0.5	0.0	0.5	0.5	0.5
	Contact	4	0.0	1.5	0.0	0.0	0.5
	Noncontact		0.5	0.0	0.0	0.0	1.0
Peer-Mirror	Contact	1	0.0	0.5	1.0	2.0	3.1
	Noncontact		3.6	1.0	0.0	0.0	3.6
	Contact	2	2.5	1.5	1.0	1.0	0.5
	Noncontact		0.0	0.0	1.2	0.5	1.6
	Contact	3	4.5	1.1	1.5	0.5	1.5
	Noncontact		1.0	0.0	1.0	0.5	1.5
	Contact	4	1.5	0.5	1.0	3.1	0.5
	Noncontact		0.0	0.5	0.0	0.0	0.5

APPENDIX EIGHT contd. 4. Affiliation (ii) Percentage of time

Source	DF	MS	F	Prob.
Social Partner	1, 4	318.6	4.2	.11
Additional Experience	1, 4	128.9	1.7	.26
Days	4, 16	74.4	0.8	.56
Blocks	3, 12	31.1	2.7	.10
Additional Experience X Blocks	3, 12	64.9	5.6	.0127
Social Partner X Additional Experience X Blocks	3, 12	81.1	6.9	.0059
Form	1, 4	938.1	19.1	.0132
Social Partner X Form	1, 4	391.0	8.0	.0481
Social Partner X Additional Experience X Form	1, 4	693.0	14.1	.0209
Blocks X Form	3, 12	41.0	3.5	.0481
Additional Experience X Blocks X Form	3, 12	52.9	4.6	.0235
Social Partner X Additional Experience X Blocks X Form	3, 12	84.2	7.3	.0050

Table of Means

		Day Block	1	2	3	4	5
Mirror-Only	Contact	1	0.0	1.1	8.8	0.9	18.8
	Noncontact		0.0	0.0	0.0	0.0	0.4
	Contact	2	0.0	0.0	35.2	19.2	34.3
	Noncontact		0.0	0.0	0.0	0.0	0.0
	Contact	3	1.0	0.2	3.0	5.0	13.5
	Noncontact		0.0	0.0	0.0	0.0	0.3
	Contact	4	0.0	9.2	12.7	43.1	0.0
	Noncontact		0.0	0.0	0.0	0.0	0.0
Mirror-Perspex	Contact	1	0.0	0.0	13.4	0.0	0.9
	Noncontact		0.5	0.0	2.5	0.3	3.4
	Contact	2	0.2	0.2	0.2	0.0	0.4
	Noncontact		0.4	0.0	0.3	0.8	0.6
	Contact	3	1.0	12.6	0.0	0.2	0.0
	Noncontact		0.4	0.0	0.9	0.5	0.4
	Contact	4	0.5	0.0	0.0	5.7	0.0
	Noncontact		2.8	0.0	0.8	0.0	0.2

APPENDIX EIGHT contd. Table of Means (contd.) 4. Affiliation

(ii) Percentage of time

		Day Block	1	2	3	4	5
Peer-Only	Contact	1	0.5	1.9	0.2	0.7	2.2
	Noncontact		0.9	0.0	0.6	0.0	4.0
	Contact	2	0.0	0.5	0.2	0.5	0.4
	Noncontact		0.0	0.5	0.3	0.0	2.4
	Contact	3	0.0	1.8	0.0	0.0	0.0
	Noncontact		0.5	0.0	0.4	0.3	0.2
	Contact	4	0.0	0.6	0.0	0.0	0.2
	Noncontact		0.2	0.0	0.0	0.0	0.7
Peer-Mirror	Contact	1	0.0	1.5	0.5	10.9	2.3
	Noncontact		2.4	0.4	0.0	0.0	4.7
	Contact	2	12.2	1.8	1.9	3.6	0.8
	Noncontact		0.0	0.0	1.0	0.3	1.3
	Contact	3	4.9	2.9	4.0	1.5	0.9
	Noncontact		0.5	0.0	0.8	0.3	1.0
	Contact	4	1.5	0.4	4.0	7.3	0.2
	Noncontact		0.0	0.2	0.0	0.0	0.3

5. Total Responsiveness (i) Rate

Source	DF	MS	F	Prob.
Social Partner	1, 4	945.6	11.8	.0275
Additional Experience	1, 4	5665.8	70.5	.0019
Social Partner X Additional Experience	1, 4	869.6	10.8	.0311
Days	4, 16	1015.9	4.2	.0166
Social Partner x Days	4, 16	980.3	4.0	.0189
Blocks	3, 12	423.5	5.4	.0141
Form	1, 4	21338.4	321.4	.0004
Social Partner X Form	1, 4	601.5	9.1	.0401

(ii) Percentage of time

Social Partner	1, 4	34.5	0.2	.69
Additional Experience	1, 4	4620.1	23.9	.0094
Social Partner X Additional Experience	1, 4	1460.8	7.8	.052

APPENDIX EIGHT contd. 5. Total Responsiveness (ii) Percentage of time

Source	DF	MS	F	Prob.
Days	4, 16	111.4	0.8	.57
Social Partner X Days	4, 16	654.8	4.5	.0127
Blocks	3, 12	141.7	2.6	.10
Form	1, 4	1870.7	15.5	.0181
Social Partner X Form	1, 4	993.0	8.3	.0458

Table of Means 5. Total Responsiveness (i) Rate

		Day / Block	1	2	3	4	5
Mirror-Only	Contact	1	4.0	8.8	17.0	11.1	35.7
	Noncontact		30.9	26.6	20.9	30.2	46.3
	Contact	2	2.5	5.7	22.9	10.1	14.5
	Noncontact		19.0	27.8	16.2	24.3	17.2
	Contact	3	6.0	8.6	24.1	10.1	13.4
	Noncontact		32.7	26.7	36.8	27.5	32.6
	Contact	4	10.8	17.7	15.0	22.5	13.2
	Noncontact		25.0	37.3	34.0	30.2	45.0
Mirror-Perspex	Contact	1	6.5	2.0	6.5	0.5	10.0
	Noncontact		21.1	20.1	13.0	7.4	36.1
	Contact	2	7.0	1.5	4.5	0.0	2.0
	Noncontact		13.0	21.0	10.0	3.5	14.6
	Contact	3	9.5	1.1	1.6	0.5	3.5
	Noncontact		18.5	6.9	14.2	11.2	26.5
	Contact	4	15.0	4.5	2.6	2.1	0.0
	Noncontact		20.0	7.5	23.5	9.4	13.6
Peer-Only	Contact	1	27.7	17.9	8.0	12.5	12.5
	Noncontact		49.9	38.8	28.6	22.6	41.6
	Contact	2	31.7	10.0	6.5	6.1	2.5
	Noncontact		47.2	28.9	20.1	38.3	21.6
	Contact	3	25.0	13.6	9.1	2.5	3.5
	Noncontact		41.0	20.1	29.1	31.6	21.1
	Contact	4	32.3	11.1	7.6	2.5	8.5
	Noncontact		37.4	32.2	21.1	21.5	22.5
Peer-Mirror	Contact	1	7.6	6.0	3.5	4.0	12.2
	Noncontact		49.0	31.2	28.1	17.2	32.8
	Contact	2	7.5	2.0	7.0	1.0	3.6
	Noncontact		46.1	12.5	25.2	11.2	20.0
	Contact	3	21.5	2.2	2.5	4.5	5.5
	Noncontact		38.6	15.4	27.6	21.1	21.0
	Contact	4	8.5	10.1	6.0	4.1	11.7
	Noncontact		38.2	30.8	21.6	9.1	33.5

APPENDIX EIGHT contd. Table of Means. 5. Total Responsiveness.

(ii) Percentage of time

		Day Block	1	2	3	4	5
Mirror-Only	Contact	1	1.7	20.9	18.6	6.5	31.9
	Noncontact		10.7	19.9	11.6	14.2	24.6
	Contact	2	1.1	3.9	48.8	25.7	43.0
	Noncontact		7.8	15.3	7.0	16.1	12.0
	Contact	3	2.4	7.7	15.5	9.8	20.5
	Noncontact		15.0	16.8	26.5	18.0	18.1
	Contact	4	6.7	22.5	19.6	52.2	12.0
	Noncontact		11.4	17.3	17.4	14.4	39.3
Mirror-Perspex	Contact	1	2.3	0.8	15.3	0.2	5.6
	Noncontact		8.7	9.2	9.0	2.7	25.9
	Contact	2	2.2	1.1	2.9	0.0	1.0
	Noncontact		6.5	12.9	5.4	1.9	6.1
	Contact	3	5.1	13.7	0.5	0.2	1.6
	Noncontact		9.7	2.0	6.9	4.6	12.3
	Contact	4	6.8	2.7	1.2	6.2	0.0
	Noncontact		11.6	3.6	9.4	5.7	5.3
Peer-Only	Contact	1	15.2	11.4	9.0	6.0	8.1
	Noncontact		26.5	26.7	19.0	16.9	32.1
	Contact	2	21.8	5.4	7.5	3.6	1.2
	Noncontact		21.3	15.3	11.2	21.4	14.0
	Contact	3	17.6	18.0	5.2	4.4	3.0
	Noncontact		18.9	12.1	13.6	26.7	10.3
	Contact	4	23.0	8.0	10.8	2.8	6.5
	Noncontact		20.2	24.4	10.1	18.6	11.7
Peer-Mirror	Contact	1	5.6	5.0	1.8	11.8	12.6
	Noncontact		26.2	17.6	17.7	7.0	24.0
	Contact	2	14.4	2.1	5.2	3.6	3.8
	Noncontact		20.1	5.9	18.8	4.4	11.8
	Contact	3	17.7	3.3	4.6	6.8	3.8
	Noncontact		21.8	7.3	17.8	8.2	9.4
	Contact	4	5.8	7.3	6.9	7.8	7.4
	Noncontact		17.0	16.3	10.7	4.2	22.8

APPENDIX NINE. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM HOME-CAGE MIRROR-REACTION RE-TEST ANALYSES

1. Aggression

Source	DF	MS	F	Prob.
Social Partner	1, 4	840.5	0.8	.57
Additional Experience	1, 4	1568.0	1.4	.03
Days	3, 12	882.8	1.2	.35

2. Exploration-Affiliation

Social Partner	1, 4	10117.5	0.2	.68
Additional Experience	1, 4	181955.3	3.7	.13
Days	3, 12	54140.4	3.6	.0454

3. Play

Social Partner	1, 4	8745.0	3.0	.16
Additional Experience	1, 4	26738.3	9.0	.0404
Days	3, 12	3242.9	7.6	.0042
Social Partner X Days	3, 12	5253.4	12.4	.0006
Additional Experience X Days	3, 12	3307.5	7.8	.0039
Social Partner X Additional Experience X Days	3, 12	4781.5	11.3	.0009

4. Total Responsiveness

Social Partner	1, 4	504.3	0.0	.94
Additional Experience	1, 4	400736.3	4.7	.10
Days	3, 12	89090.7	4.8	.0197
Social Partner X Days	3, 12	86214.3	4.7	.0218
Social Partner X Additional Experience X Days	3, 12	85729.6	4.7	.0222

APPENDIX TEN. SIGNIFICANT F VALUES, AND MAIN EFFECT F VALUES FROM MIS AND PEER-SEPARATION EXPERIMENT ANALYSES

1. Vocalization

Source	DF	MS	F	Prob.
Group	1, 6	1204.2	0.1	.83
Condition	2, 12	3655.5	3.5	.06
Group X Condition	2, 12	5775.1	5.5	.0199

2. Exploration (i) Rate

Group	1, 6	87.8	3.2	.12
Condition	2, 12	653.4	21.7	.0001
Form	1, 6	2618.1	196.0	.0000
Condition X Form	2, 12	202.0	4.8	.0290

(ii) Percentage of time

Group	1, 6	83.7	5.9	.0499
Condition	2, 12	352.4	14.2	.0008
Form	1, 6	684.0	18.6	.0053

(iii) Bout length

Group	1, 6	0.2	0.5	.52
Condition	2, 12	0.2	0.5	.64
Form	1, 6	2.2	3.0	.13

3. Affiliation (i) Rate

Group	1, 6	11.8	0.5	.51
Condition	2, 12	60.4	2.2	.15
Form	1, 6	6.0	2.3.	.18

(iii) Percentage of time

Group	1, 6	1.8	0.1	.81
Condition	2, 12	47.6	2.2	.15
Form	1, 6	8.5	0.3	.59
Group X Condition X Form	2, 12	20.2	4.3	.0390

4. Total Responsiveness (i) Rate

Group	1, 6	385.9	3.5	.11
Condition	2, 12	976.4	14.6	.0007
Form	1, 6	2921.9	138.3	.0001
Condition X Form	2, 12	258.0	4.5	.0346

(ii) Percentage of time

Group	1, 6	151.2	2.0	.21
Condition	2, 12	481.5	12.0	.0015
Form	1, 6	556.2	19.2	.0049

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